AVIATION
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Retractable landing gears

Their advantages and their design for landplanes

By Richard M. Mock

THOUGH retractable landing gears for landplanes have only come into popular use in the last few years, the idea is by no means new. In 1876 Penaud and Gauchot patented a design of an airplane which had a front landing chassis of the wheel type and a tail wheel, all retracting into the fuselage to reduce the air resistance. However, as far as can be learned the idea never took a practical form until after the War, when Dayton-Wright built a high wing cantilever monoplane for the 1920 Gordon Bennett race with the wheels retracting flush in the sides of the fuselage. The year before Lawrence Sperry built an amphibian flying boat which is believed to have had the first practical retractable gear.

However, these were special purpose planes. On normal civilian and military planes of that time the drag of the landing gear compared with the total drag of the airplane was not sufficient for a retractable gear to give enough increase in speed to warrant the additional complication. For the next ten years the problem received little attention. Today most high-speed planes are "cleaner," so that the landing-gear drag is a greater proportion of the total. Thus, the gain by the elimination of landing-gear drag is likely to be greater, though the value of tail wheel retraction is still doubtful.

As a rule, where the general arangement allows a reasonably efficient retractable landing gear it has been found that, compared with a similar design with fixed wheel type undercarriage, the speed is increased only 3-4 per cent at 130 m.p.h. Because faster planes are generally cleaner the increase grows to 6-7 per cent at 150 m.p.h. and at 165-170 m.p.h. to about 10 per cent. One well-known low-wing design had a high speed of about 175 m.p.h. with a streamlined external gear, while with the landing gear fully retracted the speed was increased some 25 m.p.h., or 14 per cent. It is possible that as much as 20 per cent increase in speed might result at 185-195 m.p.h. from retracting the landing gear on a very clean design. On designs where the wing bracing is combined with a streamlined landing gear, as on many low-wing racers or the Bellanca Airbus, the gain due to retraction would of course be debatable.

At the speeds achieved today the exact relative merits of the streamlined external gear (whether or not it is part of the wing bracing) and the retractable type depend much upon the ingenuity of the designer and the purpose, type and size of the airplane.

Space

On some types insufficient space is available in the wing or fuselage to retract the landing gear. Fundamentally, for high speed flight it is believed better to increase the frontal area slightly to provide the needed space. Thus all parts are concentrated into one mass that can be given the best possible shape, rather than have a number of separate units with the accompanying interference between them and the possible disturbances where they meet. This problem is closely tied in with problems of where to house the wheels and will be discussed later.

Weight

An increase in speed with the same power means less flying time, hence less fuel and oil required for a given flight distance. The saving in weight of fuel and oil goes to offset the additional weight of the retracting mechanism, linkages and accompanying increase in structural weight.

An example might help to illustrate this point. Assuming an airplane having 8,000 lb. gross weight, 3,000 lb. useful load, and cruising at 150 m.p.h., the addition of a retractable mechanism might increase the weight empty 60 lb., and reduce the useful load by the same amount. The fuel consumption might be assumed to be 35 gal. and oil consumption 3 gal. per hour, or a total of 230 lb. per hour. A 10 per cent increase in speed would reduce the time for a given flight 9.1 per cent, saving about 21 lb. of fuel and oil per hour (neglect-

ing that slightly smaller tanks could be used). Therefore for a 450-mile flight, if this increase in speed is achieved, the additional weight of the retracting gear would have no net effect on the pay load. This result is typical, whatever the size of the plane.

In general a fixed landing gear weighs 6-9 per cent of the empty weight of the airplane or 10-14 per cent of the useful load, though this may vary as much as 7-17 per cent. A retractable landing gear increases the landing gear weight 10-20 per cent, reduces the useful load 1-3 per cent. Airplanes of about 10 lb. per hp. loading use 7-11 per cent of their useful load per hour in fuel and oil. *Thus, with a three-hour range the additional weight would be offset by the fuel and oil saving if the speed were increased 5-7 per cent. For a two-hour flight, a 10-13 per cent increase would be sufficient.*

Cost

Outside of the greater value of a faster service, an increase in speed often means that fewer planes are needed to keep a given frequency of schedule. In addition, the flying time to cover a given distance is less, meaning a reduction of all costs proportional to flying time, such as fuel and oil, flying crews' pay, and maintenance and overhaul of airplane and engine.

Consider a conservative approximation of the additional expense due to a retractable gear. Assuming that the initial cost of the retractable landing gear is $500-$1,500, depending on the size, type and purpose of the plane, there will be an increase in cost of depreciation of 10 cents to 30 cents per hour based on 5,000 hours for the life of the airplane. Though some operators claim a retractable gear is cheaper to maintain than a fixed gear, with streamlining, assume an additional maintenance cost of 3 cents to 10 cents per flying-hour making a total additional expense of 13 cents to 40 cents per flying-hour.

Though in most instances the insurance costs would not be increased, it seems reasonable to assume a possible increase of 1 to 2 per cent in both crash and passenger liability insurance. From the Post Office Department figures, insurance represents 6.5 per cent of the total operating expense. Crash and passenger liability are assumed to constitute about 40 per cent of the total insurance or 2.6 per cent of the total flying expense. If this were increased 1 to 2 per cent due to the retractable gear the total increase in operation expenses would be only 0.026 to 0.052 per cent.

Using the most probable figures within the above range in each case, and adding an imaginary plane of strictly up-to-the-minute design and correspondingly lowered operating costs, the following table shows the increase in cost due to the addition of a retractable gear. (Only a portion of the "direct operating expenses" are directly proportional to flying time so only 30 per cent is used.)

	Tri-motor	Single motor	Theoretical plane
Flying expense per hour[1]	$119.00	$52.00	$35.00
Flying expense per hour directly proportional to flying time	$35.70	$15.60	$10.50
Additional cost of retractable gear per hour	$0.35	$0.20	$0.15
Increase in cost due to 0.04 per cent more insurance with retractable gear	$0.048	$0.021	$0.014
Total increase in cost due to retractable gear	$0.398	$0.221	$1.164
Per cent increase over part of original flying expense directly proportional to flying time	1.11	1.41	1.86

[1]Based on data compiled by Post Office Department.

An increase of 5 per cent in cruising speed, however, would mean that a flight of a given distance could be made in 4.8 per cent less flying time and hence at a saving of 4.8 per cent minus the added costs just tabulated. A 15 per cent increase would cut the time 13 per cent. It is thus apparent that in a typical case the provision of a retractable gear ought to reduce the operating expenses by from 3 to 12 per cent of the direct flying costs, or from 1.0 to 3.6 per cent of the total cost, depending upon the gain in speed. For a transport carrying from 8 to 12 passengers and cruising at 160 m.p.h., a retractable gear ought to cut total costs about $1—$2.50 per hour or 0.625—1.56 cents per mile.

Danger of failure

Another factor to be considered is the danger of the landing gear not being in the proper position at the time of landing. This may happen from any one of four reasons: (1) A structural failure of a landing gear part or the actuating mechanism, due to faulty design, materials or workmanship; (2) fouling of the wheel bracing linkage, or actuating mechanism by ice or mud; (3) pilot's neglect to lower the wheels, which can be eliminated by proper warning devices; or (4) a mechanism that is too slow to allow the wheels to be lowered in a forced landing.

Right side of landing gear of the YO-27 twin-engined high-wing monoplane. The gear rotates backward about an axis passing through the upper ends of the shock absorber strut and rear brace strut. The upper ends of the front brace strut slides back to the lower longeron. A cable to the axle is connected to an electrically-driven winch which raises the gear in 25 seconds. It is lowered in fifteen seconds. The gain in speed exceeds 10 per cent with the wheels up and the increase in the weight of the airplane over a similar fixed gear is estimated to be 90 lb.

As far as can be determined there has been no instance of a personal injury due to a retractable landing gear functioning improperly. In a forced landing in a small or bad field, especially with passengers, a "wheel-up" landing is definitely an advantage as the speed is slightly lower, the run considerably shorter and the possibility of nosing over practically eliminated. One of the leading operating companies has found it desirable to make forced landings with wheels retracted, as the expense of subsequent repairs is usually less than if the wheels were completely or partly down. In the past two years a great number of wheel-up landings have been made with various privately and commercially operated planes, and invariably they resulted in less than $1,000 damage and more often $300 or less. The greatest damage usually experienced is when the wheels are in a partly retracted position. The extent of the damage due to a wheel-up landing is usually limited to the propeller and the bottom covering of the fuselage.

To insure proper functioning of a retractable landing gear the mechanism should be designed to be simple, easy to service and maintain, and well protected against being fouled by foreign material thrown up by the wheel during take off. With the wheel opening in the bottom

of the wing or fuselage the mechanism should not be exposed to mud, which might freeze solid after the gear has been retracted. In planning the disposition of the landing-gear members, care should be taken to prevent struts from being forced into the cabin if a landing is made with partially retracted wheels. The actuating mechanism, especially cables, should not take any landing loads and the linkage must be so laid out that it never approaches dead center closely enough to require great operating force. The mechanism should not be reversible as the "down position" is approached (unless sole dependence is to be placed on a lock to hold the wheels in landing position).

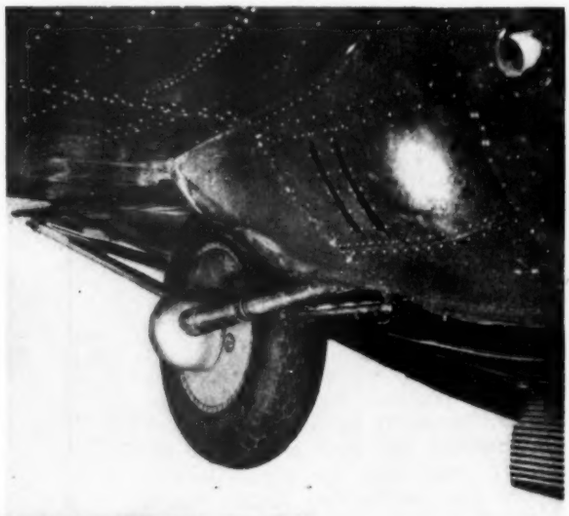
Wheel location

The best method and location for housing the landing gear varies with the type of plane. The gear can be retracted into one of five places: into the wing, the fuselage, an engine nacelle of a multi-engine design, an external fairing, or an exposed position where the frontal area or interference drag is reduced. In deciding which one to use, the aerodynamic effect of the wheel opening and of the partly retracted gear during take-off and landing immediately invites consideration. A disturbance of the flow by the opening might affect the stability, while a wing opening might affect the airfoil characteristics. These aerodynamic effects seem to be negligible however in most designs. Recent full-scale wind tunnel tests by the N.A.C.A. on a Lockheed monoplane show that a wheel-opening in the lower surface of the wing does not affect the flying characteristics when the wheels are extended. (Reference 2).

Until a year or two ago, practically all American air planes were biplanes or high-wing monoplanes. As these types have inherently less drag than the low wing monoplane their general arrangement should be more desirable (References 3, 4 and 5). The ease of retracting the gear in the low-wing monoplane is apparently one of the main reasons for its increasing popularity. It is interesting that with the same power and loading a low-wing monoplane, which gained 14 per cent in speed by fully retracting the landing gear, was only 3-4 per cent faster than a high-wing version of the same plane with a fixed streamline, single strut, tie-rod braced gear indicating that the high wing model would have been considerably faster with a retractable gear. However, as it is exceptionally difficult to retract the landing gear into the wing of a high-wing type the fuselage is a more promising location for single engine designs.

There have been many successful designs with the wheels retracting either flush into the sides of the fuselage or into the bottom. An interesting mechanism adaptable for retracting the wheels into the sides of the fuselage is shown in the illustration taken from a patent held by L. R. Grumman. A deviation from a true parallelogram is made to provide "toe-in" for landing and taxiing. Another type of parallelogram mechanism was used on the Great Lakes amphibian of 1929. The member parallel to the wheel was an oleo carrying bending from the axle. A diagonal strut hinged at the top of the oleo went downward and inward to a point in the hull. By raising the inner end of this member the wheel was raised and swung inward into a recess in the side of the hull.

To have sufficient tread and ground clearance on a high-wing monoplane with the wheels retracting into the bottom of the fuselage it is usually neces-



Landing gear in up and down positions on new twin-engined Martin bomber. A cable to the axle raises the wheels by 70 turns of a crank in the cockpit. Gear is lowered by a cable pulling upper end of rear sliding strut forward to landing position where it is locked. The retracting mechanism weighs 79 lb. complete.

Rear view of left wheel of Lockheed Orion. The cable at the right is connected to a 4-ft. long hydraulic piston and cylinder (in right leading edge) which lifts both wheels. The upper end of the strut, shown in the wheel opening, slides to the right. It is connected by cables to a 2-ft. long double-acting piston and cylinder (in center section in front of rear spar) which forces wheel down or assists in retraction. The two hydraulic cylinders are connected to synchronize the two motions. Note fender to keep dirt out of mechanism, and also note fairing for covering opening when gear is retracted. Recently a small fairing flap was added to the fairing cover completely closing the wheel opening when the wheels are up. It is stated that this increases the speed 6 m.p.h. Speeds for retraction and extension are given as 35 seconds and 12 seconds respectively.

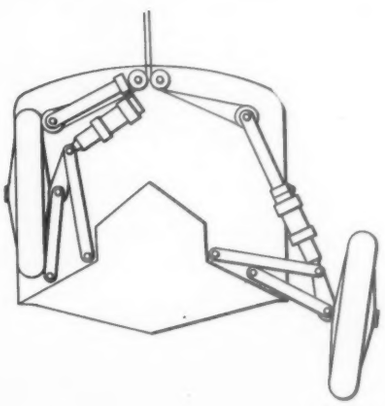
sary to either build out small stubs as on the Stinson R-3 or to have a wide fuselage as on the Burnelli. The mechanism of the Stinson is illustrated herewith. Burnelli uses a sort of curved track to give a specific path to the upper end of one member of a tripod strut arrangement. There are an infinite number of other variations with shortening or retracting struts, folding struts, etc.

To retract the wheel into a thin wing as on a biplane or an externally-braced monoplane, would usually necessitate an increase in wing thickness to house the wheel or to carry the landing loads. The Bellanca "Roma," a sesquiplane built in 1928 had one portion of the wing thickened slightly to house the wheel. The landing loads were carried as in the "Airbus" but with the wheels fully retracting into the bottom of the inner bay of the lower wing. In a biplane the wheels might fold inward into the bottom of the fuselage. It is understood that the new Curtiss YO-40 Army observation plane is of this general type, with thick filleted roots on the lower wing.

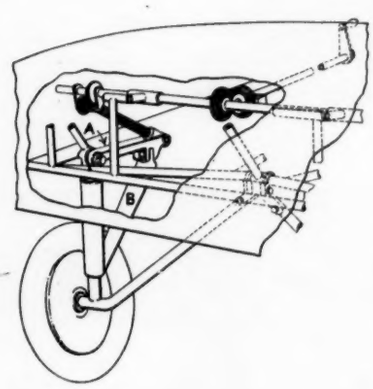
Into the nacelle

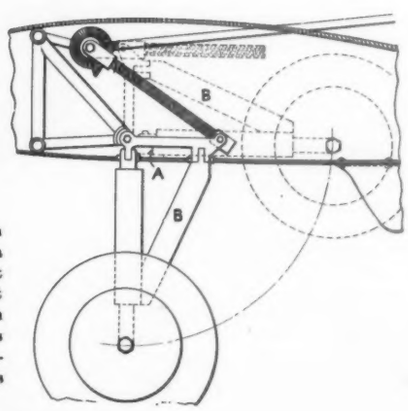
The problem becomes easiest when there are outboard engine nacelles, for the nacelle usually provides ample space for housing the gear and gives the proper tread with the wheels located under the concentrated loads. On a high-wing monoplane design with engines in the leading edge, the landing gear must be very high. Because of the great height it is almost impossible to take the side loads as a cantilever, and therefore the design must be complicated by side struts to the fuselage as on the General YO-27 (see illustration) where they remain out in the airstream when the wheel is retracted. In the new Dutch-built Fokker F-XX a compromise apparently has been reached by retaining the high wing and lowering the engine nacelles below the wing so that a completely retractable gear can be obtained with no side struts to the fuselage, the nacelles carrying all the load. Fokker seems to have decided that the slightly increased drag of the lowered nacelles did not offset the advantages of the high wing, with its inherently less drag and greater lift as well as its absence of buffeting and better passenger vision. (See page 59 and references 3, 4, and 5). However, some designers have reached a compromise in another fashion, locating the nacelle in the best position with reference to the landing gear and then lowering the wing to have the engine in the leading edge. Examples of this are the new Martin bomber, the Boeing bomber and the new Boeing transport, and the new Douglas monoplane transport.

The problem of retraction in these designs is quite similar to that in folding the wheel backward into the low wing of a single-engined plane. The simplest method seems to be to have the upper end of the rear brace strut move, while the forward struts pivot about their upper ends. On the Martin bomber, this is accomplished by having the rear member slide backward on a track when the wheel is hoisted by a cable attached to the axle. The gear is lowered by a cable pulling the rear strut forward to the landing position, where it is locked. In the Boeing Monomail a rotating screw and nut draw the upper end of the rear member forward and upward from the landing position. A number of equivalent systems might have been substituted such as a slide-tube, rack and gear, piston and cylinder, etc.



Drawing from Grumman's retractable landing gear patent. The shock absorber strut has the hinge offset, so that under compression the eccentricity tends to keep strut from buckling. In retracting, cables turn the sheave or wheel attached to the upper end of the shock absorber member. The upper end turns inward, "breaking" the strut.





Machinery for bringing up the wheels on the Boeing Monomail. Member "A" is a trussed structure to restrain "B" against side motion. The screw is protected against dirt and grit by a split dural cover which opens as the gear is retracted and closes as it is lowered. When electrically operated it is lowered in slightly over 30 seconds and raised in 45 seconds.

Hinged struts

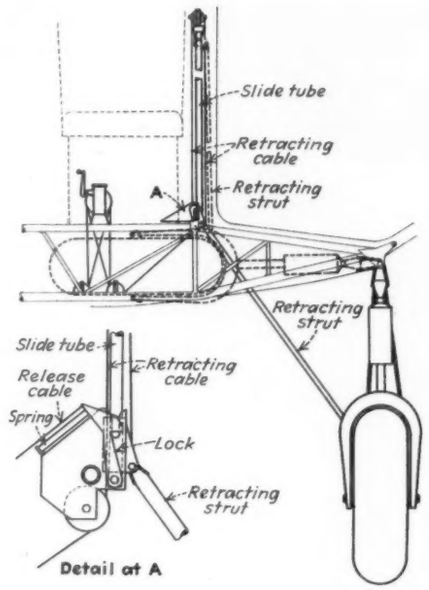
A very similar plan is to provide the rear strut with a hinge near its center and "break" the strut. The Eaglerock Bullet built in 1929, the Fokker 1930 XO-27 (forerunner of the General YO-27), the Keith-Ryder San Franciscan racer of 1931 and 1932, and the new Clark-General single-engined transport furnish examples. On the General transport an hydraulic piston and cylinder bearing against the landing-gear strut at its "breaking" point supply the actuating force. The hydraulic system automatically locks so that if a landing is made before the wheels are fully lowered the gear will remain rigid. It is stated that the gear can be raised in eighteen seconds and lowered in eight.

The most familiar design in which the wheels swing

up into the wing transversely, is the Lockheed which folds them inward. As in the Verville 1922 Pulitzer Racer, and the 1928 Bellanca "Roma," the shock absorber is hinged to the front spar. A rear brace member is hinged to the rear spar, but further outboard than the shock absorber hinge so that when the gear is retracted about an axis passing through these hinges, the wheels move backward until they are between the spars. A similar system, but with the wheels moving outward, is used on the French Bleriot transport monoplane.

As on the Lockheed the wheel on the Ballanca was raised by a cable, but instead of going to a piston and cylinder it went directly to a winch. The Bellanca had no side bracing and side loads were taken by bending in the front member, which was attached to the top and bottom of the front spar. The inner lower brace to the spar was drawn back out of the way to allow the wheel to be raised. The wheel was lowered by allowing it first to fall of its own weight and then drawing it home by a cable on the outboard side. The wheels could be manually raised in 17 to 21 seconds and lowered in seven to nine seconds.

Retracting mechanism on Stinson Model R-3. There are two parallel beams in stub wing. Side brace member lies in place of rear beam and has its upper end raised vertically by a cable actuated by a winch and worm gear. The worm gear is self locking preventing gear from falling if cranking is stopped. Gear may be "cranked" down or dropped by releasing a clutch, and locks in down position automatically. Operation of hoisting crank releases lock mechanism before actually beginning lateral movement of strut. Hydraulic arresters eliminate shock in working parts. It is stated that the gear is raised in 30 seconds and lowered in two.



Perhaps the best example of reducing the drag by leaving the wheels largely in the airstream and merely changing their position is the new Martin bomber. The wheels are retracted behind the outboard nacelles, but not enclosed. With the gear extended, there is a loss of approximately 12 per cent of the top speed with the wheels retracted. It was found that fairing over the wheels did not help the top speed, but with the wheels extended the fairing caused considerable disturbance.

In discussing the problem of retraction, some landing gear linkages and actuating mechanisms have been described. Let us consider the principal advantages and disadvantages of some of the various types. The most desirable seems to be the purely mechanical system, having only levers and hinges. It is usually simple, positive, quick-operating, and cheap to build and maintain. A mechanical cable system usually is light, simple, and cheap, but has the problem of fouling of cables and pulleys, frayed cables, failure of synchronization due to the stretching of cables, etc. A slide tube or a track is usually light, simple, cheap, and quick-operating, but it may jam. Screw and hydraulic mechanisms, though they are positive in action and can produce great forces, are usually slow unless power-actuated. They have a tendency to be heavy, and though the hydraulic systems have the advantage of being very flexible they are confronted with the problems of pumps, leaks, and congealing oil in cold weather.

Though it is not difficult to make a landing gear that may be retracted or lowered manually without great exertion, often considerable time is necessary. The Department of Commerce requires that a gear be lowered in 60 seconds or less. This can usually be accomplished by a clutch which disengages the slow-acting retracting mechanism of high mechanical advantage allowing the gear to drop of its own weight. Auxiliary means, such as rubber shock absorber chord, are sometimes used to hasten the lowering of the wheels.

On commercial transports and military planes it is felt that unless the landing gear naturally comes down very quickly the addition of power-operated mechanism to an emergency hand-actuated mechanism is desirable. The pilot's duties are ever increasing, and especially during landing in bad weather his attention should not be distracted by lowering the landing gear. On military types the power-operated type is desirable to avoid distracting the pilot during formation take-offs and landings. Power actuated gears are usually electrically driven, though it should be feasible to utilize the air pressure to raise or lower the gear by a flap.

Mention was made of warning devices to insure that the pilot has not forgotten to lower the wheels before landing. Most of these are electrical and are actuated if the throttle is retarded when the wheels are not locked in the down position. Originally lights were used but they proved inadequate and were replaced by a horn near the pilot's ear. The latest device, on the Clark General transport, is an electric motor with an eccentric weight which causes the control stick to vibrate (see page 59, this issue). In addition most planes have indicators, usually colored lights, showing when each wheel is locked in the up or down position. The Department of Commerce requires an indicator "to show the position of the wheels at all times."

Closing, I wish to acknowledge my appreciation to the Army Air Corps, and to those manufacturers and engineers who have so kindly supplied me with data and illustrations. Unfortunately, space did not permit credit being given in each instance nor the publication of all of the material desired.

REFERENCE

[1] "Cost of Air Line Operation," by W. I. Glover, 2nd Assistant Postmaster General, Buffalo, N. Y., meeting of Aeronautic Division of A.S.M.E., June, 1932.

[2] "Eighteenth Annual Report of N.A.C.A." 1932.

[3] "Effect of Fillets on Wing-Fuselage Interference," by A. L. Klein, Berkeley, Cal., meeting of Aeronautic Division of A.S.M.E., June, 1932.

[4] "The Interference Between Body and Wings of Aircraft" by Parker and Klein, University of Toronto Aeronautical Research Paper No. 22.

[5] "Interference," by E. Ower, *Journal* of the Royal Aeronautic Society, July, 1932.

The factory

Airplanes built without

EVERY now and then someone writes in to AVIATION to tell us that we are failing to give the home-built airplane its due. We heard that so often that finally we decided there might be something in it, and we went out to investigate this homemade airplane thing and find out what it all amounted to. We wrote to everybody who was listed as having licensed or identified within the past year an airplane that didn't appear to be a factory product, and a large proportion of those to whom we wrote answered. The photographs and captions on these pages are a part of what we found out.

Roughly speaking, identification numbers have been issued in the past year for 225 planes of this class. Many of them have never gone beyond taking an identification number, and as closely as we can estimate about one-third of them have reached the point of getting off the ground. Approximately one-half of those that fly are built from the plans of one of three well-known types,—Heath, Pietenpol, or Church. Almost all, whether built from purchased plans or from home designs, are monoplanes,

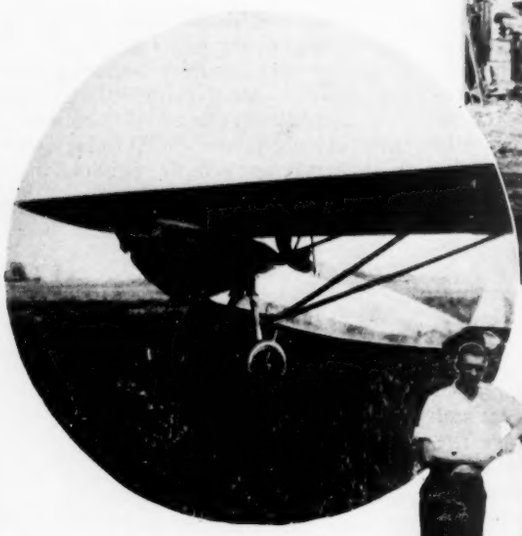
Above: F. A. Yokell uses a two-cylinder opposed 30-hp. engine, made up of Harley Davison, Chevrolet, and Star parts.

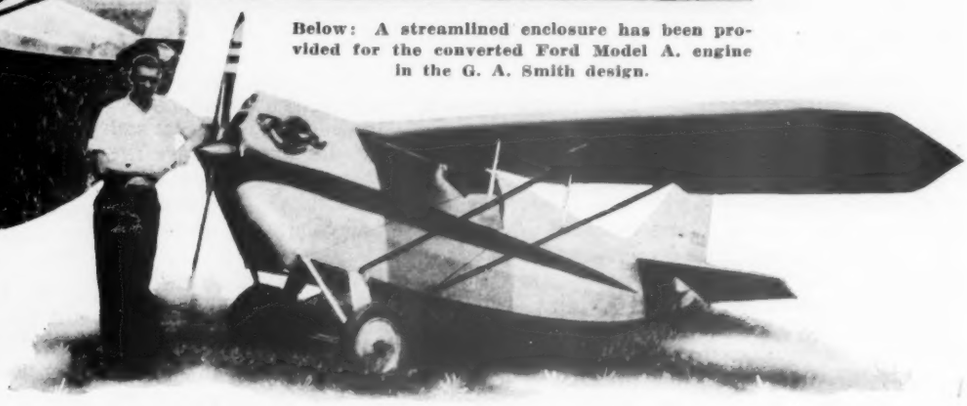
Right: A modified Pietenpol design for two persons has been built by David Comstock. The engine is the Ford Model A.

Below: The Church midwing design has been modified by C. A. Zajicek and is powered by the Church Marathon engine of 41 hp. Construction is conventional.

Left: A four cylinder engine developing 27 hp. is employed in the parasol monoplane design of Pasco M. Melone

Below: A streamlined enclosure has been provided for the converted Ford Model A. engine in the G. A. Smith design.





Above: Robert Dow has designed his airplane around the 2-cylinder, 25-horsepower Wright Morehouse engine. Wing fuel tanks provide a capacity of 7 gal.

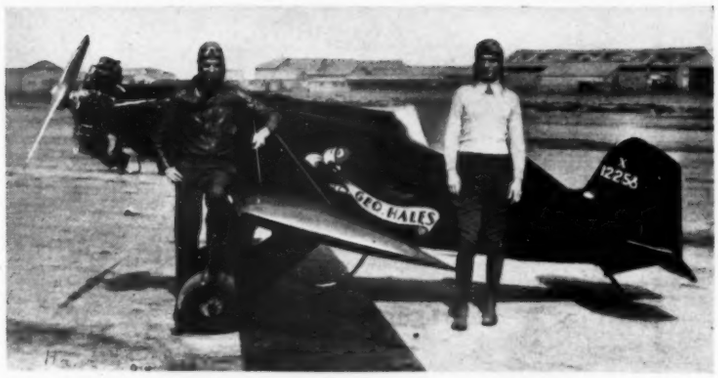
in the home

benefit of mass production

and most are high-wing monoplanes. Not many of the machines have any very unusual characteristics, but a number show real competence and real care in detail design. Some, on the other hand, are plainly so badly out of balance that it is easy to understand why they are never flown, or so badly overweight as to suggest that lead pipe must inadvertently have been substituted for chrome-molybdenum tube.

Some of the amateurs are deliberately disdainful of the industry's products, and one of the most active of them writes to us that they are "real red-blooded young men who never would think of buying an airplane as long as they could build one."

Power-plants are scattered in type, but very few of the builders have had the financial ability or the inclination to buy airplane engines, even of the smallest size. About half of the home-made machines have modified motorcycle power-plants, while most of the rest depend on engines ravaged from Fords. In that, as in other respects, the photographs that we show are good typical samplings of the best that home construction has to offer.

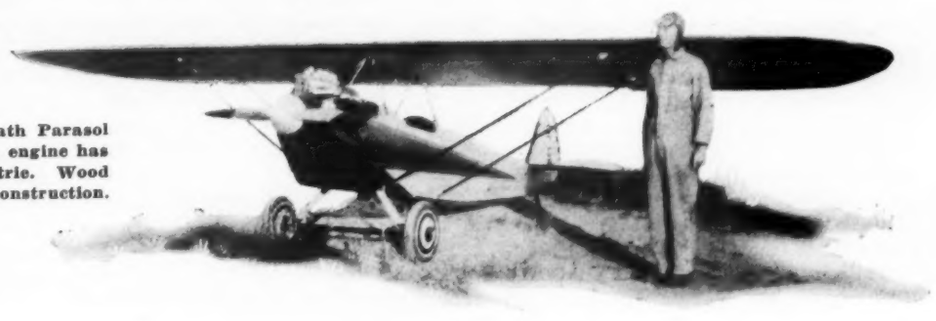


Above: The Hales low wing, with the 40 hp. Salmson AD9 engine has been flown more than 100 hours. Fuselage and wing are of wood with fabric covering.

Above: A 30-hp. Henderson motorcycle engine is used in the Haines low wing.

Above: The Church Mid Wing built by A. F. Wright is powered with the two-cylinder Aeronca.

Above: B. H. Pietenpol, whose design is familiar in the Middle West, employs a converted Model A. Ford engine, a wood and fabric wing and a plywood and fabric fuselage.



Right: A modified Heath Parasol Heath-Henderson 23 hp. engine has been built by C. M. Petrie. Wood and fabric are used in construction.

THE EIGHTH OF A SERIES ON MAINTENANCE

Thunder bird's nest

Observations at Pan American Airway's Brownsville base

By S. Paul Johnston
Assistant Editor of AVIATION

ONE cannot help but wonder how far into the future the ancient Central American peoples really saw in weaving their fantastic legends of Quetzalcoatl, the feathered god who rode the winds. Did they foresee dimly the days when tropic suns would glint on silver wings high over trackless jungles of Yucatan, or when frozen passes of the impregnable Mountains of the Sun would reverberate to the galloping of a thousand man-made horses? What frenzied supplications might rise from many a crumbling temple-pyramid could but the bronzed priests of a thousand years ago witness the diurnal passing of Pan American's thunder birds!

Consider the topography of the P.A.A. routes from Brownsville, to Tampico, to Mexico City, to Tapachula, to Managua, thence down the continental funnel to Panama. There are no railroads to follow, no continuous pattern of towns and villages with ready communication facilities, no interested and far-seeing governmental agencies to provide lighted airways and weather information services; instead, hundreds of miles of trackless jungle and rugged, snow-capped ridges 15,000 ft. above the sea, tremendous areas between population centers where habitation is figured on the basis of a fraction of a human being per square mile, weather which varies in a single hour's flight from the dank atmosphere of the lowlands to the blinding fogs and blizzards in the mountains, and last, but not least, the negative influence of a string of politically dissociated Central American republics. It is against such odds that the Western division of Pan American operates. Therein lies the rationalization of the super-meticulous attention given to the flying equipment at Brownsville.

In the present series of articles on maintenance, the tendency towards centralization has been pointed out. Brownsville has been made divisional maintenance base although the routes extend southward for a distance almost as great as that between New York and Cheyenne, Wyo. Instead of two flying days away from the home port, as is common on domestic airlines, ships which make the long haul to the Canal Zone and back are away from Brownsville for at least four flying days (usually six or seven calendar days). This, together with the fact that three divisions meet at Cristobal, necessitates a more elaborate repair base at Panama than might otherwise be necessary, and introduces a degree of decentralization within the division itself.

The inspection and maintenance of all flying equipment of the Western division, as well as the direct supervision of the overhaul shops at Brownsville, are in the hands of R. D. Sundell, division engineer. With the exception of radio (which comes under the control of the divisional communications engineer), Mr. Sundell is responsible also for all field and shop equipment in Mexico and Central America. The general administration of the division is handled from headquarters in Mexico City, but on technical matters and on matters relating to maintenance personnel the division engineer reports directly to Mr. A. A. Priester, chief engineer, at New York City.

Wasp powered Fords constitute the backbone of the flying equipment on the Western division. A few Fokker F-10s and Fairchild single-engined ships are still on the active list, but they are distributed at several points along the line for emergency service only. One of the Fairchilds is maintained at Brownsville for instrument flying instruction. The student-pilot's seat is enclosed in ground glass windows to simulate fog flying conditions.

Engine servicing

On the long Canal Zone run, which represents about fifteen hours flying time from Brownsville to Cristobal, a complete running check is given each engine at the overnight stopping point, and the regular Pan American "long" servicing is given at Cristobal. This includes (1) fill gasoline tanks; (2) check oil levels; (3) remove and inspect front spark plugs; (4) lubricate and inspect boxes for valve clearances, etc.; (5) remove and clean gasoline strainers; (6) check rear spark plugs for tightness; (7) check motor mounts; (8) remove and lubricate push-rods and (9) clean engine thoroughly. On the return trip to Brownsville the same items are checked, but in addition the following work is done; (1) change engine oil; (2) change spark plugs; (3) check magneto breakers for wear and clearance; (4) remove and clean carburetor jet plugs, and flush out carburetor; (5) remove and clean all gasoline and oil strainers. Any particular difficulties noted in flight by pilots are also taken care of.

Airplane routine

Airplanes follow about the same schedule as the engines. Flight inspection is given at all intermediate stops along the line, and a fifteen-hour check is given at Cristobal, including a complete inspection of all external and internal structure, controls, tire-pressure, etc. This is repeated, but somewhat more thoroughly at Brownsville. The procedure with regard to airplanes differs somewhat from other lines in that each airplane is practically overhauled at periods corresponding with engine overhaul intervals. This is not merely a superficial inspection, but frequently involves the pulling off of engine nacelles, tail surfaces, landing gears, wing tip sections, and all cowling. All parts of the structure are thoroughly examined for corrosion or cracks, and any doubtful parts or rivets are immediately replaced. Cabin furnishings including chairs, floor boards, and cer-

General view of sheet metal department and airplane overhaul shop. Note clean and orderly appearance, which is the rule and not the exception.

tain sections of the wall paneling are removed completely at frequent intervals, and all parts repainted revarnished and polished. Any parts of the upholsteries which are noticeably worn are replaced. At the same time instruments come out and go to the shop for examination and overhaul, and all radio equipment is pulled and turned over to the communications division for check and overhaul. Loose or damaged cowling is repaired and all cowling and other sheet metal parts are repolished or spot-faced. Ships come out of overhaul with all the earmarks of factory finish.

Storage batteries are pulled after each day's run, and are held for charging at stop-over points. All batteries, therefore, circulate up and down the line, but sooner or later pass through Brownsville where complete records are kept. B.G. IXA spark plugs are standard equipment. They are pulled at Brownsville at about 40-hour intervals when they are disassembled, cleaned, checked and tested for firing under pressure. An ingenious testing apparatus has been devised at Brownsville (since made standard for all Pan American shops) which will be described in the "Servicing Short Cuts" section of a later issue. One man is responsible for all spark plug work. About 100 plugs a day go through the shop.

Propellers are inspected at every stopping point. At fifteen-hour intervals they are examined more carefully for cracks or damage from stones or rain, and the hub cones and nuts are checked. They are pulled at engine overhaul intervals for complete inspection and overhaul, which includes disassembly, etching, microscopic examination, tracking, pitch-setting and balancing.

Plant layout

The plant at Brownsville is housed in two standard Pan American Airways double-ended steel hangars, each with a single-story lean-to along one side. They are located on the municipal field (operated by Pan American Airways) about 200 yd. south of the terminal building which houses waiting room, ticket office and general administrative personnel. Both hangars are similar to the ones used at Dinner Key at Miami (see "Checking Caribbean Cruisers," AVIATION, July, 1932). In accordance with standard P.A.A. specifications, roof, sidewalls and doors are covered with Robertson composite protected metal.

The more northerly hangar is devoted to routine servicing of airplanes. A small shop in the southwest corner is given over to the radio section for equipment servicing and parts storage. The principal lean-to is on the northern side, and houses the division engineer's offices and the general storeroom. An auxiliary lean-to has been built along the south side to enclose air-compressor equipment, the remotely controlled radio transmitting station, and washrooms. The other building takes care of all overhaul activities. The main hangar floor is used for assembly and disassembly of planes, with the sheet-metal shop occupying a considerable portion of the area along the southern wall. Upholstery and window-glass replacement is handled in the southwest corner. Adjacent to this section a door leads out into the wood-shop, which is located in a small building external to the hangar proper. The engine overhaul, the machine shop and the propellor overhaul shop are situated in the lean-to on the north side. A Skinner oil reclamation plant is installed in a small detached building behind the hangars.

Plant "housekeeping"

Special mention should be made in passing of the general condition of all shops and equipment at Brownsville. In few plants are such high standards of cleanliness and good housekeeping maintained. Special racks or clearly designated stations are maintained for the storage of all equipment which is not in use, and unusual pains are taken to keep floors, benches, and areas around

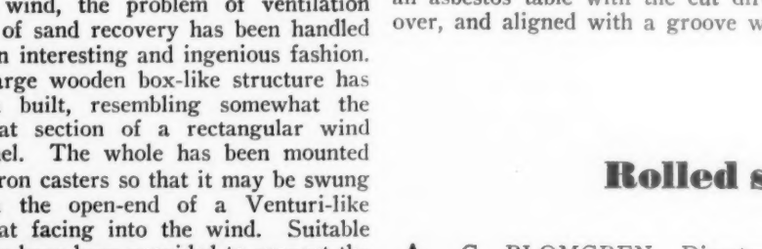
the building entirely free of all dirt and refuse. Equipment of all sorts, including tools and machinery, is thoroughly cleaned and carefully painted. It is obvious that everyone in the station, from the division engineer down to the unskilled laborers, takes particular pride in keeping everything in first-class condition.

Due to the particularly equable weather conditions in Brownsville a number of variations in layout have been made which could not be tolerated in more variable climates. For example, the Oakite cleaning vats are located out-of-doors behind the hangar, thus eliminating the ventilating problem encountered when they are enclosed. The most interesting equipment from this point of view, however, is the sand blasting apparatus. Due to the particularly erosive nature of this operation, is is usually necessary to make some very special kind of arrangement to prevent damage to enclosing building and to personnel. At the American Airways shops in Dallas, for example, the Pangborn equipment is located in a small building completely lined with sheets of rubber, and provided with a special ventilating system for the discharge of the air and the recovery of the sand. At Brownsville, however, thanks to the constancy of the prevailing wind, the problem of ventilation and of sand recovery has been handled in an interesting and ingenious fashion. A large wooden box-like structure has been built, resembling somewhat the throat section of a rectangular wind tunnel. The whole has been mounted on iron casters so that it may be swung with the open-end of a Venturi-like throat facing into the wind. Suitable racks have been provided to support the work in the throat section, and the operator with his nozzle (his head protected by a suitable mask) simply stands with his back to the breeze and blasts merrily away. The used sand is thus carried into the throat of the box where it impinges against suitably placed baffles and falls into a hopper to be collected for reuse. The sand and air storage equipment was built in the shops and is of a very simple design. The tanks, valves and piping stand in the open air adjacent to the movable box.

Glass replacement

Mention has been made previously of a window-glass department in connection with the overhaul shop. On most domestic airlines, barring accident, window-glass replacement is a minor matter, but in the tropics, not only does moisture tend to work in from the edges, but the sunlight causes the color to change, and reduces the transparency. It has been found more economical to maintain a glass-cutting plant at Brownsville than to ship in sizes cut and finished to exact dimensions. In addition to the usual polishing and finishing equipment, a gadget is used which overcomes the difficulties commonly encountered in cutting composite panels. It is seldom difficult to cut the glass parts of the panel, but trouble comes in cutting the interior pyralin sheet smoothly without causing the edges to separate from the glass. In this case the glass on both sides is carefully cut along the intended line with an ordinary glass-cutter. The sheet is then laid on an asbestos table with the cut directly over, and aligned with a groove which contains a long heating element of the resistance wire type. This is heated electrically to a bright-red heat which causes the pyralin core to expand slightly and thus to separate the edges of the glass. This done, it is an easy matter to run a sharp razor blade along the pyralin, and effect a clean separation. This simple device has saved the shop a great deal of inconvenience and considerable money. It is typical of the sort of thing which is to be found at Brownsville—details which exhibit unusual combination of good sense and good engineering (see also "An Aid to Good Shipkeeping," page 62 this issue, and "Visualizing r.p.m.," AVIATION, August, 1932).

One carries away from Brownsville an impression of extraordinarily careful work in a beautifully kept plant. High-grade workmanship is the rule in the maintenance plants of all the first-class airlines, but at Brownsville it is obvious that a little extra attention is given to all details. One is inclined to wonder whether these extras can really be justified on a dollar-and-cents basis, but when gazing down onto hundreds of square miles of dense tropical forests, or while watching the grim and snow-covered passes of the continental divide slip by below, the painstaking activities of Mr. Sundell and his associates at Brownsville are easily recognized as an utterly invaluable form of insurance.



Sandblasting cylinders in the open air at Pan American's Brownsville base.

Rolled snow runways

A. C. BLOMGREN, Director of Aviation for the State of Idaho reports (*The Highway Magazine*, October, 1932) a method used with considerable success for preparing landing runways for aircraft at remote mountain mining settlements during the period of heavy snowfalls. Pusher plows are not practical due to the very deep snows, and rotary plows were not available. It was decided to try to compact the snow by rolling. Snow rollers were made up from 8 or 10-ft. sections of 30-36 in. Armco corrugated culvert with the ends plugged, mounted on suitable bearings in a rectangular frame to which a team of horses could be harnessed. The roller had to be of variable weight to work well in snow of various consistencies, and it was therefore decided to use a light drum, and to add weight to the frame as required, by means of sand bags. By running the roller over the snow after each fall of 3 or 4 in., runway strips were made on which the heavily loaded supply planes could land or take off from either skii or ordinary landing wheel equipment. In several cases, snow originally 3 to 4 ft. deep was compacted to a hard surface, whose thickness ranged from 10 to 18 in. Due to the difference in texture of the rolled and unrolled snow areas, runways thus prepared are clearly visible from the air for great distances in the daytime. At night they are marked by oil flares.

THE SECOND OF TWO ARTICLES

Progress of aviation law

By
George W Lupton, Jr.

AIR transportation needs a clean-cut statement of the law with respect to the liability of the private pilot and the air transport company and its pilots for injuries occasioned by the operation of airplanes. As and when air travel becomes universal a certain toll of life and limb and loss of property will inevitably result, as with other forms of transport, and so will many a law suit.

Assuming then that out present air traffic laws are adequate, at least for the time being, and assuming that future traffic legislation and rules will advance with the growth of aviation, what will be the attitude of the courts toward the aviator-defendant sued for having injured a person or damaged property?

The Common Law, transplanted from England by the Pilgrims, or before, is based on precedent. Legal thought is deeply rooted in history. It is common knowledge that the law is always twenty-five years behind the times, but the great broad principles of law which have grown from centuries of litigation and relitigation are certain to be just. The contempt and criticism heaped upon our judicial system is only too justified when aimed at the administration of the law, but the law itself, in its broad principles, is as perfect as human intelligence and experience can make it. In some few instances hardship is wrought by its application, but in the vast majority of cases full justice results if the law is honestly applied.

It is to these broad underlying principles that the judges will look when aviation and its concurrent activities are full before our courts. The automobile, the railroad, and the vessel offer the closest analogies to the airplane. The first two have been the cause of thousands upon thousands of law-suits, resulting, not in wholly new law as might be supposed, but merely in new applications of the old-established basic principles. The vessel is the vehicle of a specialized branch of law—admiralty law—which is inapplicable to aircraft, at least insofar as the present discussion is concerned. As the railroad and the automobile were confronted with seemingly new legal problems, so also is aviation facing the necessity of solving similarly new legal riddles.

Out of the unending procession of a legion of bitterly contested automobile and railroad cases have emerged nearly uniform rules governing the responsibility of the motorist and the common carrier to the pedestrian, the passenger and the shipper. For instance, innumerable cases have decided that the common carrier is liable for all loss or destruction of goods in its possession as carrier unless the loss is occasioned by an act of God or by the actual negligence of the victim. So also, the common carrier in transporting passengers is bound to exercise as high a degree of care, skill, and diligence as the means of the conveyance employed and the circumstances of the case will permit. On the other hand, the driver of an automobile or a person going about his ordinary business cannot be held responsible unless he is guilty of negligence. And even if he is negligent he generally need not pay if the person injured is also negligent. These principles are so simple and well understood that we unconsciously govern our daily lives by them. But it is these two very different and distinct principles—that of "insurer's" liability, such as the common carrier's, on the one hand, and that of the "no negligence—no responsibility" liability of the motorist on the other,—to which the courts and legislatures have to look when seeking precedents for the new skyway case. The underlying reasons for the old rules will be re-examined. The rule most aptly applying to the airplane will be applied.

Two types of cases

Two great obvious types of cases have arisen: first, damage by aircraft to persons or property on the ground, and second, damage to persons or property aloft. The now famous cases of Guille vs. Swan decided in 1822, by the courts of the State of New York, is the classic example of the first type. In that case Balloonist Swan landed in Farmer Guille's potato patch, and his fall attracted a large crowd to the scene of his misfortune. He was compelled to pay for the damage done by his balloon when he landed, and also for the damage done by the crowd.

The ruling in this case is now the law. Forced landings must be paid for if any damage is done, regardless of the care used by the pilot. When airports are established at twenty-mile intervals and motors are as dependable as the tides, the question will seldom arise. The farmer located midway between the more widely separated airports will clear off a runway and operate a service station and landing field in conjunction with his farm. The fools that drop tools on people's heads will stand alone at the bar of justice, and their punishment cannot be too severe.

It is interesting to note that the question of negligence was no concern of the judge that decided Guille vs. Swan. Swan was simply guilty of trespass. Negligence is lack of due care, and due care has been defined in thousands of cases as "that care the ordinary prudent man would exercise under the same circumstances." Regardless of the fact that Swan may have used the same care in his flight as any other prudent balloonist would have used under the same circumstances, he was compelled to pay the land-owner for the damage done. The difference between a balloon, at the sport of the winds, and an airplane or airship, ordinarily easily controlled, is obvious. The former is inherently dangerous, the latter less dangerous than the automobile or the train, if competently operated. Nevertheless the Uniform Law of Aeronautics, which has been passed in a number of states, adopts the rule of this early balloon case and provides:—

"The owner of every aircraft which is operated over the lands or waters of

this State is absolutely liable for injuries to persons or property on the land or water beneath, caused by the ascent, descent, or flight of the aircraft, or the dropping or falling of any object therefrom, whether such owner was negligent or not, unless the injury is caused in whole or in part by the negligence of the person injured."

Early cases

A line of early cases uniformly held that fair associations and amusement parks sponsoring balloon ascensions were jointly liable with the balloonists for injury to spectators, usually upon the theory that proper safeguards had not been provided.

To saddle the aviator with absolute responsibility seems to be going too far. It is only another instance of the law being behind the times. Today, a plane licensed with an NC rating is as safe as an automobile. But somehow this distrust of aircraft has persisted despite the fact that last year there was but one death in every million miles flown. It seems only fair to place the aviator on a parity with the motorist, or at least to give him a chance to explain his conduct.

And the old, established rules of law afford a precedent. Between the "absolute liability" theory and the "no negligence—no liability" theory we find an intermediate theory that fits the airplane precisely. This theory has been given a fancy Latin name but is really quite simple. It is known as the res ipsa loquitur doctrine—that is "the thing speaks for itself." An eminent legal authority has stated the rule as follows:

"Whenever a thing which produced an injury is shown to have been under the control and management of the defendant, and the occurence is such as in the ordinary course of events does not happen if due care has been exercised, the fact of injury itself will be deemed to afford sufficient evidence to support a recovery in the absence of any explanation by the defendant tending to show that the injury was not due to his want of care."

The burden of proof

In many cases of airplane accidents there will be no ground witnesses, or if there are witnesses their ability to testify as to the causes of the accident would be nil. The application of the doctrine merely places upon the aviator the burden of proving that he used due care. To hold him absolutely responsible regardless, as the railroads are held, is manifestly unjust. To hold him absolutely responsible on the theory that the airplane is inherently dangerous is equally unjust, because the theory is not true. To force the plantiff to prove the aviator was negligent is asking him to do the impossible, but to require the aviator to prove he was not negligent affords substantial justice. Here, then, is another flaw in the law of the air that the legislatures or the courts must remedy. To class the aviator with a common carrier is a fundamental injustice which must be righted. Various state laws have been passed, some adopting one extreme rule, some the other, and some a modification of both.

In Sollak vs. State of New York, decided by the New York Court of Claims in 1929, the plaintiff was a passenger in an automobile being driven along the side of Wicks Flying Field, near Utica. Traffic being heavy, the car in which the plaintiff was riding was stopped, when he was struck by a plane being flown by a state agent. The "res ipsa loquitur" doctrine was applied, judgment being awarded the plaintiff.

In Stoll vs. Curtiss Flying Service, New York (1930) a father sued for damages for the death of his son, one of two passengers who were killed in an accident that happened near Roosevelt Flying Field. Stoll, Jr., had paid five dollars for a hop. The plaintiff's bill of particulars alleged that the pilot made a short turn at near the stalling speed, at an altitude of only 200 ft. and in a locality where the pilot knew that dangerous air currents existed. The trial judge instructed the jury that its job was to determine whether or not the pilot was exercising the care of a reasonably prudent pilot in the performance of his duty, and then proceeded to instruct it on the "res ipsa loquitur" rule. At the first trial the jury disagreed. At the second trial it returned a verdict for the defendant, in effect holding that the testimony adduced by the defendants proved that the accident need not have been the result of the pilot's negligence.

Common carriers

In passing, it should be stated that the responsibility of the transport company, if it be considered a common carrier, would be precisely the same as that of a railroad. That is, the utmost care and diligence must be exercised. In a case tried before the United States District Court in 1930 the defendant, Standard Air Lines, Inc., was engaged in carrying passengers from California to Arizona. While going through a canyon the pilot ran into an unusual fog, lost his way and crashed, killing a passenger. The defendant company had required the deceased to sign a ticket denying the common-carrier status of the company, but the judge ruled that such a procedure was invalid. The judge in his charge flatly stated, however, that an error in judgment on the part of the pilot was not necessarily negligence, even under the common-carrier rule. Some of the ground witnesses had testified that the pilot had been within view of an intermediate airport while in the fog, but had rejected his chance to land and elected to endeavor to find his way out. The jury found for the defendant.

Commission rulings

Executives of air-transport companies have only begun to face that great problem which has confronted the railroads since 1887, the year the Interstate Commerce Act was approved:—to wit, control by federal and state public utility commissions. This interference has amounted to a practical dictatorship by the state and federal government of the rates to be charged, the service to be rendered, the schedules to be maintained. Eventually the air transport company must face the problem, for as certainly as the bulk of all passenger traffic of the future shall move by air, so certain it is that these commissions will exercise their powers. Already we find a number of commission rulings directly concerned with aviation.

The general theory of commission control is that the public utility shall be allowed a fair return upon its capital investment. Obviously this theory works a hardship in many instances. For instance, if a radio service with an investment of but $100,000 performs the same service as a cable company with $1,000,000 invested, should it be allowed a fair return upon the investment or upon the service rendered? The problem confronting the aviation industry is the same. With but a fraction of the amount of capital invested it will perform the same passenger service as the railroads at three to five times the speed. How should its allowable profit be computed? It is a new problem. What is the answer?

It is to the interest of the industry to put its house in order against the impending visits of these commissions. Engineer, accountant, and executive all must be prepared to present testimony that will guarantee rates and regulations that will insure the company a fair return for the service rendered as well as upon the capital investment.

This problem is not a pressing one. The commissions have yet to give it full consideration. But they have already had before them many interesting problems. Two or three samples may be selected to show the range of possible action.

In a matter before the Colorado Public Utilities Commission two air carriers, Pikes Peak Air Commerce, Inc., and United States Airways, Incorporated, applied to the commission for a certificate of convenience and necessity over approximately the same territory. Such a certificate is a common prerequisite to doing business. The Commission listened to evidence as to the desire for such a service by the people in the cities to be served, the dependability of the service rendered

by each company in other areas, the proposed routes and flying times, the types of planes to be used, the proposed summer and winter schedules and their relationships to connecting airlines, the affiliations and consequent resources of each company, the possibility of air-mail contracts from the government, and, of course, the convenience of the public. Both carriers proposed to charge ten cents per mile and they agreed that there was only enough business for one line. The former company was granted the certificate to the exclusion of the latter, the Commission expressing its regret that the traffic available would not support both competing lines.

In 1927 the Gettysburg Flying Service, Incorporated obtained a certificate of convenience and necessity from the Pennsylvania Public Service Commission upon its showing that it had carried 16,000 passengers in a period of two months without injury to a single passenger and with but one forced landing. The Commission, in granting the application for a one-year period, said "Commercial aviation to be profitable and popular must be safe, convenient, comfortable, reliable and not too expensive." The Commission required the company to establish at the airport, conveniences similar to those provided at the railroad stations, with adequate service for parking automobiles under proper police regulation. It also required the applicant company to carry liability insurance for the protection of passengers and public and the filing of monthly statements covering the number of passengers carried and the service furnished.

The following year (1928) Battlefields Airways, Incorporated, were denied an application for authority to duplicate the service of the Gettysburg Flying Service, Incorporated. The Commission's decision contained the following language:

"The Commission recognizes that the policy of the nation and state is to foster and encourage aviation.—Common carrier transportation by aircraft must be developed for some time at least by and through private enterprise, which should not be required to struggle for an existence in the competitive field under conditions as existing in this case.—This Commission desires in every way possible under its regulatory powers and duties to encourage the growth and development of commercial air service."

The struggle of a year ago between Century Pacific lines and American Airways, with the former carrying passengers free of charge between points in Arizona to establish a claim to consideration before the Arizona Railroad Commission, is too well remembered to need detailed description.

Already competition between rival companies has been the cause of compromise rulings. For instance, in Nevada three applicants were granted certificates of public necessity between various points in the state. The base of operation of each applicant was in a different city. The certificates were granted subject to a plan whereby an applicant receiving a call for service in the home port of a rival applicant was required to wait two hours for the home pilot to decide whether to handle the business himself or to resign it to the "foreign" operator. Rulings of that kind are a sufficient reminder that the interests of the whole aviation industry are deeply involved in what the imaginations of 48 state commissions or commissioners may produce.

Conclusion

These articles have but touched the bare surface of the rich field of aviation law. Problems will multiply as the industry grows. The great work being accomplished by the Aeronautics Branch of the United States Department of Commerce, under the Air Commerce Act of 1926 would afford material for many an interesting page of reading. The necessity for uniform field and air traffic rules, the new questions that will arise under State Workmen's Compensation acts, the effect of aviation on insurance law, the problems of local legislation and of criminal jurisdiction and eventually the necessity for uniform international laws respecting air commerce are but a few of the problems confronting the industry and its attorneys. It is trite to caution foresight, but intelligent foresight will save the industry and the small operators of aircraft many a heartache and many a dollar.

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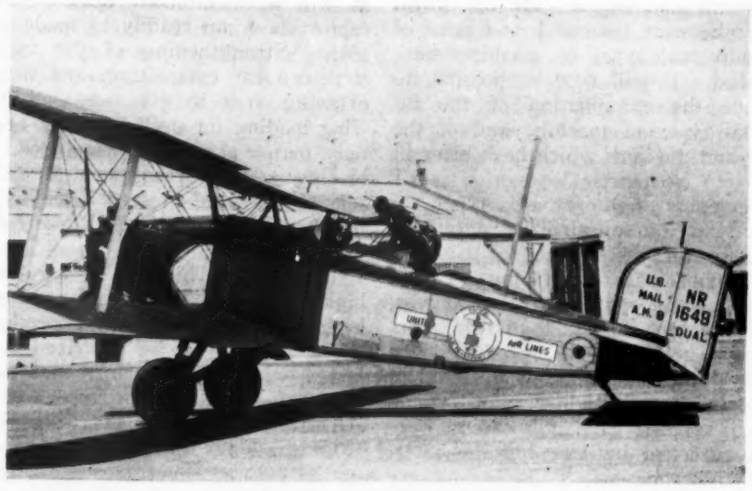


Boeing radio-equipped trainer.

Radio comes to the aid of the student

THAT "all alone" feeling many of us remember so well from our first solo should be a thing of the past as radio becomes a part of the equipment for training machines. The installation of speaking tubes or other inter-cockpit communication systems was a great step forward in dual student instruction—an idea further extended by the radio. Students going solo may thus receive the familiar fatherly advice from their instructors, making the break between the dual and solo periods less nerve-racking.

Recognizing the advantages of student control offered by a radio telephone system, the Boeing School of Aeronautics has equipped all its primary and advanced training ships with complete transport type radio equipment. The consequent elimination of much of the mental hazard associated with early solo stages has materially reduced the dual instruction period. Even in advanced solo stages, a great deal of time is saved, for the instructor, watching his student from the ground, can instantly criticize or correct any faulty maneuvers. For cross-country instruction, the advantages of the radio equipment are obvious. A student receives continual advices from the local weather bureau, and can be notified of any adverse weather conditions at the home airport, or be directed to land at some emergency landing field. Students are thus familiarized with the operation of the radio under conditions similar to those which exist when they are flying as transport pilots.

GREAT BRITAIN (PART TWO)

The equipment of air forces

By

Maj. Oliver Stewart

IN THE previous article dealing with Great Britain's service air equipment the system adopted for linking up service demands with the work of the aircraft industry was outlined, the guiding principles which have hitherto obtained in the selection of aircraft and engines for the Royal Air Force were indicated, and some of the individual types of machine were described. It will now be possible to continue the examination of the individual types of machine and of the policy and the aims which have brought them into existence.

Interceptor fighters are types of single-seater pursuit airplanes developed expressly for the defence of London. They subordinate everything to performance and powers of maneuver, and carry fuel for less than two hours flying. The type is the production of strictly local conditions, of the kind of problems that defending pilots would have to solve if England's capital were to be attacked by air; but the interceptor has many advantages as an ordinary pursuit machine and apart from increase of fuel capacity little else needs alteration. For naval work too, as will be mentioned later, the interceptor class can readily be made available. Strengthening of the fuselage structure for catapulting, and increase of wing area to give an appropriate wing loading for deck landings, are the only major alterations demanded. The leading interceptor fighter in the British service at the present time is the Hawker Fury with Rolls-Royce Kestrel engine.

The Fury, which is a wire-braced biplane and is the aircraft with the highest performance in series production for the R.A.F., was described in the last article and its performance figures were given. In accordance with the Air Ministry's custom it was not selected from drawings but after actual competitive trial against other aircraft. There were several other aircraft competing for this Air Ministry order but there was only one that came near to displacing the Rolls-Royce Fury and that was the Fairey Firefly, also with the Rolls-Royce Kestrel engine, and also an externally braced biplane of about 32 ft. span. It has been sold in quantity to the Belgian air force, more than one entire squadron being equipped with it.

Above: The Hawker Audax, a development of the basic Hawker Hart design intended for Army co-operation work. Right: One of the day bombers, the Fairey Fox, with the Rolls-Royce Kestrel engine.

Courtesy of "Flight"

Between the Fury and the Firefly machines there was little to choose, and it was more a matter of personal predilection on the part of the judges than anything else that decided the issue, for the Firefly and the Fury both have their special points and are both of them machines capable of exceptionally high performance with full military load. Constructional methods differ and there are points of difference in the general lay-out, the most important being the use in the Firefly of high aspect ratio ailerons on both top and bottom wings, while on the Fury ailerons are used on the top wing only. It is claimed that the use of ailerons on both wings gives superior powers of maneuver, especially at great heights where lift falls off. The Firefly has an adjustable stabilizer, and in a number of minor respects, such as the placing of the guns, the two machines differ. The performance leaves little room for choice. The Firefly, fitted with a propeller chosen for high speed gives a maximum speed of 217 miles an hour at 13,000 ft. and of 193 m.p.h. at 26,300 ft. With a climbing propeller it reaches 19,700 ft. in eight minutes six seconds if the supercharger is brought in at once, while its speed with this propeller at 13,000 ft. is 200 m.p.h.

These figures give an idea of present requirements in the R.A.F. for the interceptor class; but there are also the landing qualities and the handling qualities. Both the Fury and the Firefly have a wide speed range and can be comfortably brought in to land at an approach speed of 75 m.p.h, while the actual landing speed is much lower. They are capable of all the aerobatics, and their performance enables new point to be given to some of the maneuvers. For example, a roll may be performed as the machine takes off, and height

Left: A resemblance to recent American practice is noted in the new Fairey Monoplane Bomber, powered with Kestrels, and designed for troop carrying if required. Bombs are stowed within the wings and the gun mountings may be folded away.

Courtesy of **"Flight"**

Right: Kestrel engines are also used in the Handley Page, Heyford, a new heavy bomber produced for the R.A.F.

Courtesy of **"Flight"**

gained in the process. Two complete turns of a vertical upward spin are possible without any need for a great previous accumulation of speed through diving. The machines are steady in terminal dives when speeds of more than 400 miles an hour are reached.

In view of the prevalent idea in countries outside Great Britain that terminal dives do not form part of the testing program for British aircraft, it is worth mentioning that actual speeds of more than 400 miles an hour in terminal dives with the Fury and the Firefly have been recorded on many occasions by test pilots and that all prototypes are submitted to the diving test and, if desired, are demonstrated in this test.

Ease of handling

Altogether the Royal Air Force believes that it has in its interceptor fighters aircraft which show a notable advance on any previous types and which are capable of out-performing any aircraft that could be brought against them by any other air power. Moreover, it is confident that this exceptional performance has been obtained without making the aircraft difficult to fly. The Furies and Bulldogs are perhaps the most easily handled single-seater fighters that have ever been standardized in the R.A.F., and the belief is widespread among pilots in England that there are at present no other military aircraft in the world which embody at once such high performance with such marked powers of maneuver and such easy handling qualities as the Rolls-Royce Hawker Furies. [Obviously this is open to argument, but Major Stewart is presenting, as we desired, the British point of view.—Ed.]

The R.A.F. interceptor class of military aircraft has a family resemblance to the continental racing motor car. It is a high-efficiency machine, with its subsidiary functions of carrying a crew and armament kept always in the background. High speed, high rate of climb, good powers of maneuver, these are the three essentials to which everything else is subordinated.

Disarmament moves between the nations of the world, while they are likely to affect the equipment of air forces, are not likely to affect the interceptor class so much as the other classes because it comes nearest to being purely defensive. Owing to its limited endurance and its general layout, which demands the suppression of drag in all its forms, the interceptor would be grossly inefficient for anything but its particular work of climbing up and attacking raiding aircraft. It could not be used with any great success for attack upon ground targets, because the weight of projectiles it could carry would be insignificant.

We may now leave the single-seater class and pass to the day bombers. Once again in the Royal Air Force today the aircraft constructor has been able to retain a casting vote in the design as against the officers who would place military requirements first; with the result that, aerodynamically, the day bombers, like the interceptor fighters, are satisfactory and the performance high.

In the R.A.F. a sharp line of distinction is drawn between the day and the night bombers. The day bomber is usually but not always single-engined; it is always of the wire-braced biplane form, it carries a small load of bombs, perhaps only 500 lb. with full range for the single-engined machines and rather more than double this for the twin-engined machines. In the single-engined form the emphasis is once more upon performance. One gunner is carried and he is provided with a gun ring or with some special mounting intended to protect him from the slipstream. The pilot in the single-engined machines has one fixed gun firing forward through the field swept by the propeller, in the manner of the twin guns of a single-seater fighter or interceptor.

Day bombers

Representative of the two types of day bomber now in use in the R.A.F. are the single-engined Hawker Hart with the Rolls-Royce Kestrel engine and the twin-engined Boulton & Paul Sidestrand biplane with two Bristol Jupiter or Pegasus engines. The engines of the Sidestrand are mounted on the lower wings, just far enough out for the tractor airscrew blades to have sufficient clearance from the fuselage. Between the single and the twin-engined types of day bomber military theory fluctuates uncertainly. The advocates of the single-engined machine believe that performance is of primary importance to the day bomber and that a 500 lb. load of bombs is sufficient for one machine, provided it can fly fast. The advocates of the twin-engined machine, on the other hand, believe that firing power is essential to the successful day bomber, and that at least 1,000 lb. of bombs must be carried by each machine.

It is not intended here to enter into this controversy, which is one I dealt with at some length in a previous article in AVIATION, but it is worth remarking that the problem shows no signs of being finally solved. While the single-engined day bomber has made some notable advances recently in performance, so has the twin-engined day bomber. Moreover the twin-engined machine has been developed to give high powers of maneuver, and the

Boulton & Paul Sidestrand can be looped, rolled and flown upside down, so that in combat it is not necessarily out-maneuvered by the fighters.

The Hawker Hart is now in use in six squadrons of the R.A.F., and one squadron is equipped with the Hart modified as a two-seater fighter and renamed the Demon. The Hart is also used for Army co-operation work, a branch of air operations often called reconnaissance in other services, [or observation, as in America] and for navy fighter and reconnaissance work under the names Audax and Osprey. It is the practice of the Air Ministry to name aircraft according to function as well as design, so that the Fury appears also as the Nimrod and the Hart as the Demon, the Audax, and the Osprey. Change of aircraft equipment brings with it change of name. The system has been criticized as tending to conceal the design basis of the aircraft. Modification of the aircraft so that it may perform specialized duties does not extend to the basic design. That remains the same for all varieties, and so it offers the opportunity for a measure of series production which would be unattainable if basically dissimilar types were chosen for each duty.

The Kestrel engine

Before leaving the interceptor fighters and day bombers something must be said about the Kestrel engine, which forms the power unit for both the Fury and the Hart and their descendants, and for many other new R.A.F. machines. The Rolls-Royce Kestrel is a twelve-cylinder, water-cooled 60 deg. V type engine. As delivered to the R.A.F. to-day, it gives 580 b.hp. at 11,500 ft., but by the addition to the fuel of a small quantity of tetraethyl lead the supercharger can be brought in at ground level when, at normal revolutions, 2,250, an output of 710 b.hp. is obtained and, at maximum allowed revolutions, 2,700, an output of 840 b.hp.

It is to be noted that the fuel specification for the R.A.F. gives an octane number of about 76, although the Air Ministry is preparing to raise this by stages to a rating nearer 90. [The same trend is of course manifest in America.] Another point is that ethylene glycol cooling is not used at all in standard R.A.F. machines. The only change from air and water cooling is likely to be to evaporative, [or "steam"], cooling. This has been tried in the new four-engined Gloster troop carrier, in the Vickers four-engined bomber and in other aircraft.

The Kestrel engine is not top-overhauled at all, and the present general overhaul interval is set by the Air Ministry at 500 hours. There is a likelihood of its being further extended for certain classes of work in the near future. The Furies and Harts have shown that they can do more than 800 hours flying without showing any signs of requiring structural reconditioning, and there is as yet insufficient experience to estimate the life of these "airframes," which is the word adopted in British aviation to mean the airplane structure as distinct from the engine and from the complete machine.

The "Heavies"

Both the remaining classes of R.A.F. machine to be dealt with are in the heavy group, the night bombers and the flying boats; but before summing up the present position in Great Britain and after dealing with the heavy classes, a few words will be added upon the training aircraft.

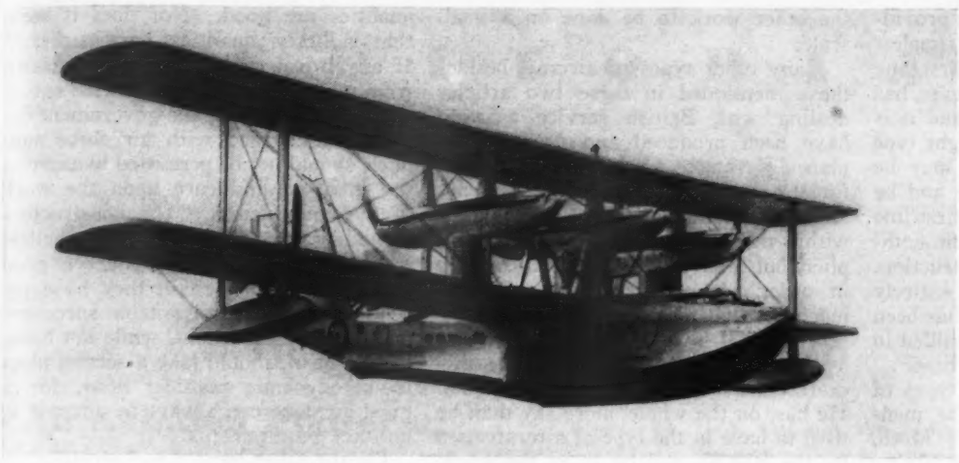
All types of heavy bomber in use in the squadrons at the present time are wirebraced biplanes with pilot housed forward of the wings, one gunner in the nose, one just aft of the wings and, for protection against attack from below and to the rear, one either in a tunnel in the underside of the fuselage or in a special cockpit at the extreme tail. Positions for the bomb aimer vary slightly, but the position favored is in the nose of the fuselage with some arrangement to permit a freer view downwards and the mounting of bomb sights. Twin-engined designs have been favored to the exclusion of all others up to the present, though experimental aircraft with three and four engines have been produced. The function of this type is accepted as being chiefly night attack on ground objectives; but it may also be called upon in emergency for conveyance of troops and spares.

The heavy bombers at present in use in the R.A.F. squadrons are of three types, the Handley Page Hyderabad, the Handley Page Hinaidi, and the Vickers Virginia, and all three of them are obsolescent. Indeed it is in the bomber class that the R.A.F. is most backward, the existing types being slow and inefficient when judged by modern standards.

At the same time new machines have been built experimentally, and one

Right: Wing slots and Tandem engine arrangement are feature of the Kestrel powered Gloster Bomber transport. Above: Ranging between the day and night bombers are the torpedo carriers, represented by the Vickers Vildebeest (Bristol Pegasus). Wing slots are essential in this type for maneuvering.

Courtesy of "Flight"



The Short R 6/28 Flying boat powered with six Rolls Royce Buzzards weighs 31 tons and is the latest and largest of its type in Great Britain.

Courtesy of "Flight"

type, the Handley Page Heyford, with two Rolls-Royce Kestrel engines, has been selected for the equipping of one complete squadron. Unless disarmament conferences cause alterations in the program it is likely that further squadrons will be equipped with new machines, probably Heyfords, in the future.

The Handley Page Heyford, which may therefore be regarded as the latest heavy bomber in the R.A.F., was known as the Handley Page 38 before its acceptance by the Air Ministry. It represents the outcome of a deliberate study of the relationship between horsepower and bomb load and between horsepower and speed. Bomb load is favored by a large size of aircraft and the multiplication of power units up to a certain point, while high speed is favored by the medium sized aircraft and the optimum size and number of power units is found between the two extremes. It is claimed that the Handley Page Heyford night bomber strikes this optimum for a range in the region of 1,000 miles.

View and fire power

Other features of the Heyford are the position of the fuselage close up under the top wing, the object being to minimize interference with the more valuable top side of the wings, and to give the crew the best possible view, and the built-in undercarriage which is incorporated in the bottom wing. The wheels are housed in casings extending down for approximately three-quarters of the diameter of the wheel and merging into the lower wing. Shock absorbers are also entirely enclosed so that no part of the undercarriage is exposed other than the wheel casings, which merge with the wing, and a segment of the lower part of each wheel. The biplane form has been chosen in this case to keep down to a minimum the projected area for searchlights to pick up at night and to give the highest possible degree of maneuverability consistent with the load carried.

Both the Handley Page Heyford and the Fairey monoplane which was produced at the same time, include many detail features of interest, among them the arrangements for the gunners. There is the retractable "dust bin" turret in the Handley Page and there are the "disappearing" positions in the Fairey. The "dust bin" turret is a cylindrical metal housing closed at the lower end and containing gun and mounting and a seat for the gunner with a sufficient aperture to fire through. The housing is retractible and also rotatable, the rotation being done by hand wheel by the gunner while at his post with the housing let down in the "action" position. The gun mounts in the Fairey are folded away when not in use so that no additional drag is set up.

An offshoot of the heavy bomber is the bomber transport which, as the name implies, doubles the work of heavy bombing and troop and spares carrying. The two R.A.F. squadrons equipped with this type have the Vickers Victorias, and the Gloster Company has produced a four-engined bomber transport with which it is hoped the Victorias will be replaced later on. The value of these heavy transport machines to the R.A.F. has been demonstrated during the disturbances in Cyprus and in Iraq and the British air staff is at present inclined to press forward with development of the type. The Gloster has four evaporative-cooled Rolls-Royce Kestrel engines and the wing span is 95 ft. The all up weight as a troop transport is 28,000 lb. and the operational height is from 12,000 to 15,000 ft. It may be added that the Fairey heavy bomber is convertible for use as a troop transport, when it can take fifteen or twenty men. The Fairey's total weight is rather over 8½ tons.

Torpedo planes

A class of aircraft which comes between the heavy bombers and the day bombers is represented in the R.A.F. by the Horsleys and the Vickers Vildebeest. These are torpedo aircraft and they are found in four squadrons. The Vickers Vildebeest has the Bristol Pegasus air-cooled radial engine and its total weight is 7,955 lb. Frise type balanced ailerons are used on both wings and slots are fitted in the upper wing as they are to all R.A.F. multi-seater aircraft. The value of slots to the torpedo carrier is particularly high because it occurs sometimes that rapid pull-outs from high speed dives have to be made and then there is possibility of a high speed stall through the increase of the centrifugal loadings. Slots maintain the machine's stability under such conditions.

Flying boats form a class in which the R.A.F. has specialized on account of the value of establishing over-sea air communications to a scattered Empire like that of Britain. Seven squadrons have flying boats which come entirely under the R.A.F. and do not form part of the Naval Air Arm. The most widely used flying boat is the Southampton, a production of the Supermarine works which is now a branch company of Vickers. The Blackburn Iris is the largest flying boat standardized in the R.A.F., though, as will be mentioned, much bigger boats have been built singly, and it has recently been fitted with three Rolls-Royce Buzzard engines in place of the Rolls-Royce Condors that formerly were used. The Saunders-Roe A7 with three air-cooled engines has been performing well. The new Short flying boats such as the Singapore II and the R 6/28, which weighs more than 34 tons, have attracted a great deal of attention because they are the largest yet made for the British service and they represent steps toward the genuine sea-going self-contained aircraft that is yet capable of high performance in the air. The R 6/28 has six Buzzard engines arranged in three tandem pairs. This arrangement has given good results in the Singapore II, which has two tandem pairs, and has enabled speeds to be obtained which were formerly thought to be beyond the reach of a flying boat having sufficient sea-worthiness for ocean operations.

Training

Before concluding this survey ot British service aircraft something must be said of training machines and training policy. It was at one time thought that, for training the service pilot, a se-

ries of aircraft must be available providing gradual steps up from the simplest form of flying machine to the first line service aircraft. This view, however, has been abandoned in the R.A.F. and it is now believed that, when the right type of aircraft is selected, a pilot may be trained throughout on one type and be prepared to go on to any first-line service machine afterwards with nothing more than a little verbal instruction. Clearly he will not at first be entirely at home in the new type; but it has been shown that confidence can be instilled in a very short period of flying time.

Among the straight-through types of service training aircraft may be mentioned the De Havilland Tiger Moth, which is in use at the Central Flying School and elsewhere, and the Avro Tutor. Both these machines can be converted for use in any branch of service training. They offer the full range of aerobatics and they enable fighting practice, bombing, photography and all the other work to be done on a small scale.

Many other types of aircraft besides those mentioned in these two articles dealing with British service aviation have been produced and used. Ship planes of various kinds, including those for use in submarines, float seaplanes and amphibians, all these have come within the purview of the service supplier, but I have had to omit them here in order adequately to deal with the machines that form the backbone of the service as it is today.

At the moment in Britain the aircraft constructor is in the ascendant. He has, on the whole, more say than he used to have in the type of aircraft used by the R.A.F., and he is on the whole less hampered by unnecessary restrictions (a condition the exact opposite of that which now applies in British civil flying). The result is that the performance figures of the later type machines are high and that aerodynamic qualities are good. Nor does it seem that military qualities have suffered. If any broad conclusion can be drawn from a survey of British service equipment, then, it is that the government department charged with air force supplies, should not be permitted to exercise too great an influence upon the work of the constructors. The constructors alone have the information and practical experience which will produce a good airplane, and in Britain they have recently achieved some notable successes. Military considerations, while not being lost sight of, should take a second place to aerodynamic considerations, for a good airplane can always be adapted to military requirements.

On the other hand a bad airplane, no matter how carefully gun positions, fields of fire, outlook, bombing arrangements, radio equipment and other military matters have been seen to, can never be of very much value on active service.

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The problem of noise

An abstract of an article by A. H. Davis, D. Sc., physicist, N.P.L. in the *Journal of the Royal Aeronautical Society*

WITH the increasing mechanization of modern life, the noises to which human ears are subjected are multiplied many fold, and their control becomes more and more important. Pure tones,—i.e.—those of smooth wave form, within the normal range of pitch of our auditory apparatus, usually cause no discomfort, but irregular, non-repeating wave forms, and even pure tones of unusually high or low pitch or of extreme loudness, cause annoyance in varying degrees up to actual physical pain. For practical purposes, any excessive unwanted sound may be defined as a noise.

Noises in aircraft are extremely complicated in make-up, arising from many different sources, and for this reason are difficult to analyze. Since interference with speech is the factor most noticeable to the average passenger, a qualitative study in the cabins of a number of airlines in flight indicated that although conversation was naturally easiest in those machines where the general noise level was the lowest, the high frequency whistling, hissing, or tapping noises caused the greatest interference. Certain low pitched drumming noises, although of relatively great loudness, had less effect than nondescript noises with high frequency characteristics.

Numerous independent observations made in England and America are in fairly close agreement. A few of the noise levels from different sources from numerous tests are given in Table I.

Further studies of propeller and engine noises indicated that the high-speed propeller was the greatest single source of airplane noise, but that the noises of the exhausts, and the general engine clatter were practically of the same order, making it almost impossible to make separate studies of propeller noises in actual flight. Laboratory tests on the ground have been conducted, however, and the relationships of Table II were obtained for a two-bladed propeller of conventional design at a distance of 80 ft.

Table I: Comparison of sounds in decibels

Threshold of hearing	0
Quiet London garden	20
Conversational range (loud to quiet)	40–60
Busy street traffic (average)	60–75
Elevated train (openstructure)	90
Silenced Napier engine exhaust	100
Hammer blows on steel (indoors)	115
Airplane engine and propeller (unsilenced)	118
Threshold of painful sound	130

Table II: Propeller noise

Tip speed (ft. per sec.)*	Engine (r.p.m.)	Noise level (decibels above threshold)
550	1200	72
740	1600	89
850	1860	100
960	2100	110

*Horsepower varies as the tip speed cubed.

Obviously one of the most important steps in reducing propeller noise is to use large diameter propellers and gearing to reduce tip speed. This introduces another noise factor, screaming of the gears, but measurements have indicated that the overall results are generally toward reduction of sound. Table III gives the results of tests on similar airplanes with geared and direct drive propeller. These figures indicate also that the location of propellers with relation to passengers is important, and suggest that other factors than safety dictate the placing of baggage compartments in the propeller rotation plane.

Engine exhaust noise may be reduced about 10 decibels by suitably designed silencers without seriously affecting back-pressure. Engine clatter arising from reciprocating parts must be reduced by more detailed studies of the motions and cycles of such parts. The latter is a problem for the engine designer.

Table III: Comparison of noise of geared and ungeared engines

	(direct)	(geared)
Propeller tip speed (ft. per sec.)	830	685
Propeller diameter (ft., in.)	9–9	10–9
Pitch (ft.)	5.7	8.7
Air speed (m.p.h.)	90–100	90–95
Average noise level above threshold, in plane of propellers (decibels)	107	91
Average noise level above threshold in rear of cabin (decibels)	95	85

EDITORIALS

AVIATION

EDWARD P. WARNER, *Editor*

An Aviation Platform; Progress Report

IN THE early part of 1932, and running through four consecutive issues of AVIATION, we printed a platform of the planks which seemed to us important for the aviation industry and its various divisions to take to heart and stand upon. At that time we promised not to let the subject drop. We promised to return to the platform later and to amend it or to supplement it, or to say how it looked in the light of new experience. Now that a year has passed, the accounts ought to be audited. On the whole there proves to be little occasion for change in the platform of 1932, and where change is called for it is in the direction of eliminating planks bearing on problems that no longer exist. There is remarkably little occasion for saddling ourselves with new cautions or precepts beyond the list that seemed appropriate a year ago. The easiest way of charting a course for 1933 is to take the old platform and pass it in review, item by item.

Fundamentals

1. Be properly skeptical towards miracles. This is still a necessary caution, but it no longer demands any such emphasis as it seemed to need a year ago. Though a proneness to panaceas is still evident in spots, we no longer let them sweep us off our feet. The situation in this respect has certainly improved at least 150 per cent during the year. So far as an undue credulity still offers a problem, it is most manifest at the moment in exaggerated ideas of the levels to which air express traffic can be built in the near future, and of the inherent benefits to be derived from great increases in the speed of operation.

2. Abandon delusions of grandeur. This one is a closed chapter. The work has been done. The evil practice of using 1929 as a yardstick has been abandoned. The psychological deflation of the aviation industry to a proper realization of the true dimensions of its own activities is complete.

3. Cut out the hippodroming. Still a problem. The general public is still given too much of an opportunity to think of aviation in terms of the sensational. The situation is not so bad as at the beginning of 1932, but it is still quite bad enough. Delayed opening parachute jumps and wing-walking, to say nothing of all sorts of freak stunts with airplanes and autogiros, cannot be shown before large crowds without definitely injurious reactions upon the aircraft industry and the sane use of aircraft.

4. Develop an industry policy on legislation. The need for coherent action at this point remains a pressing matter. The industry is divided within its own ranks upon what it wants and upon how to get it. Unless internal differences are resolved in caucus, and some kind of an intelligent consensus presented to Congress, we shall be in danger of suffering regulatory legislation that nobody wants. The Aeronautical Chamber of Commerce has been doing good work in presenting the industry's case, particularly on appropriations, but the work needs to go farther and faster. It needs the most serious thought and the personal participation of the leading executives of manufacturing companies and of airlines.

5. Prepare to fight the question of air space ownership. This has lain dormant throughout 1932. There has been no major development in the law of aerial trespass. The absence of further airport cases has been encouraging, but we cannot expect the subject to remain quiet forever. It is still important that the whole resources of the industry be mobilized in readiness to defend such a case, or to oppose an action like that by which the Santa Barbara airport was crushed under the terms of a zoning ordinance, wherever the danger appears.

6. United front against state regulation. Though there has been little aeronautical activity by state legislatures in 1932, the danger of unwise and excessive state activities still exists. The tendency which some of the states show to build up permanent aeronautical bureaus and to find in them attractive jobs for political appointees is a most alarming one, even though the amount of work the bureaus do may at the present be small. State legislation must be very closely watched. Most of it is at best of dubious value and at worst definitely

harmful. The best general rule for the individual is to oppose everything new about which he feels the slightest doubt.

Transport

1. Strive for agreement on optimum operating conditions. Progress here has been as rapid as could be expected. Certainly there is a much closer approach to agreement on what constitutes a good transport plane and a good operating organization now than could have been found a year ago. This one can be crossed off the list as requiring no special attention in 1933.

2. Bigger and better traffic surveys. On this point, the record is not so good. A number of individual lines have continued to do good work on the analysis of actual and potential passenger and express traffic, but cooperation has been scanty. The Air Transport Section of the Aeronautical Chamber of Commerce can have no more important business than to find out just what section of the American public is traveling by air, and just what's the matter with the other sections.

3. Agree on a policy towards the air mail. Carried comparatively low down on the list a year ago, this item would have to go to the very top if a rearrangement were made now. The air mail has had splendid support from the public for several years, but it still has plenty of foes in Congress. A new administration is about to arrive in Washington. Air transportation ought to be prepared to spike the guns of its enemies by meeting the new Postmaster General with a definite program of a long-term development of the air mail service, and with definite proposals for a policy which will keep the industry in the strong position to which it has been brought, and also provide for a gradual reduction of the Post Office Department's net outlay. We believe that the American Congress and the American people are quite prepared to go along with the air mail and support its development as long as necessary, but it is only reasonable that they should want to have some very definite idea of where they are going. The operators, who alone have the knowledge and experience to formulate such an idea, ought to do their best to give it to them.

4. Co-operate on express. A year ago the Railway Express agency represented the only attempt at cooperation, and it included less than a third of the country's transport services. The formation of General Air Express within the past year has brought an incalculable improvement. Some independents still exist, but they play a minor part. Taking the nation as a whole, the air express business now has a perfectly proper organization, and all that is needed is a harmonious relation between the two main agencies and a simple arrangement for the exchange of inter-line traffic between them. This need no longer be reckoned as a problem of the industry.

5. Co-operate for economy. There is some progress to report under this heading for 1932, but not enough. There is still too much duplication of effort. There are still too many cases in which each airline runs its own transportation facilities to the airport, its own ticket-selling facilities, and its own general air-travel promotion work, in apparent disregard of the very existence of other lines. There have been some notable instances of cooperation during the past year, but we need more and better ones. That survives as one of the main points to emphasize in 1933.

6. Work on the reduction of noise. At least one operator and two or three manufacturers have taken this matter very seriously indeed, and have gone after it in an entirely new spirit. If they and others will carry on as vigorously during the coming year as during the one just ended, we shall soon be able to appeal to sensitive travelers to forsake the railroad for the airline on the grounds that the airplane is much less distressing to the ears than the train.

Manufacturing

1. Live within our means. Nothing more needs to be said on this score. The deflation of the airplane factory is complete. With the rarest exceptions the factories are adjusted to present-day production, and instead of optimistically waiting for the return of the days of an immense turnover they have reorganized to make a profit on gross volumes as small as those of five or six years ago. It was a painful operation, but a necessary one, and it is virtually finished.

2. Make the product fit the market. This remains exceedingly important. Airplanes are still too generally built in terms of the point of view of the highly skilled pilot, without enough regard for the feelings of the ordinary citizen who might become a purchaser. That stricture doesn't apply universally, and certainly progress has been made, but there is still occasion for a lot of delving into the mind of the average business man and into his reactions towards matters aeronautical. There are about a hundred thousand people in the United States who could well afford to maintain airplanes, but who have no apparent thought of getting any at the present time. There must be *some* kind of an aircraft that will reach a substantial proportion of those people. It is up to the industry to find out what kind of a machine will do the trick, and then to build it. The steady pressure to expand the markets for existing types are all to the good, but relatively speaking too much effort has been expended on selling the public the idea of using existing aircraft, and not enough on finding out whether or not it would be possible to produce a machine upon which a certain section of the public could be sold more easily.

3. Control production at the source. The situation on production statistics is, if anything, worse than a year ago. Reports are so slow in appearing as to be of almost no value in the industry's planning. Such

reports may seem of relatively little value with business as slack as it is now, but they will become immensely important as soon as there is any change for the better. Now is the time to start a policy of weekly exchange of full information upon work completed and work in progress, in order that the exchange may be working smoothly by the time the need for it becomes urgent.

4. Stop selling at a loss; and

5. Stop price concessions on used planes. Except for a few dealers and still fewer manufacturers, this is cleaned up. The desperate campaign of reckless price-cutting which hung threateningly over our heads from the beginning of 1930 to the beginning of 1932 no longer impends. The responsible people in the business fully realize that there is no sense in bringing about general ruination. The industry has had its lesson with competitive selling on a basis of price sacrifice, and we believe that the lesson has been quite adequately learned.

6. Develop an industry policy on the regulation of commercial design and construction. Unlike most of the previous subjects under the general heading of manufacture, this one still calls for attention. The industry is still full of people who say that this, that, and the other thing ought to be done about government regulation, and then hastily add: "but don't quote me." With a new administration impending, it is particularly important to the manufacturers and users of airplanes to decide whether it is in their interest to have an identical continuance of the present policy, or to have more regulation, or to have less. Whatever they decide they must be prepared to support their decision with strong arguments, particularly if they want a reduced amount of regulation in opposition to the general governmental tendency to extend and tighten its grasp on everything which it has once touched. Furthermore, it does no good simply to say that there should be less regulation. That isn't a policy, but a profession of faith. The people who offer it must go on to say just where the amount of regulation can be reduced and how it can be done without danger of harmful results. They ought not to delay any longer in making up their own minds on the matter.

7. Survey of the uses of aviation in industry. This, like the co-operative traffic survey recommended for the transport lines, still awaits attention. The Chamber of Commerce made some inquiries, and AVIATION has dug out as many records as possible of unusual uses of airplanes, but the need for a really comprehensive study still exists. It will cost money, and the industry will have to provide the money, but if it is intelligently undertaken it cannot fail to open up new markets and to provide a lot of new selling arguments for use in markets already known to exist.

8. Give sportsmen an incentive to use planes. Some progress has been made here, but not nearly enough. The cruises of the Amateur Air Pilots' Association have been splendid indications of what can and should be done. Special amateur meets, such as those recently organized at the Boston Airport, are additional straws in the wind. To make private ownership seem worth while to a really large number of sportsmen, however, there must be ten times as much activity as has been attempted up to the present time.

9. Get more seaplane bases. On this score it is only necesary to say that it is still as important as ever, especially from the point of view of encouraging private ownership of planes, and that no progress was made during 1932. We still have practically a clean sheet upon which to write the record of organization of American water-flying facilities.

10. Co-operate in foreign markets. Here, too, there has been practically no progress, though the relative importance of export trade perhaps looms larger than ever before. American companies have gone after that trade with great energy, but they have had to duplicate their sales organizations overseas, and to disperse a substantial part of their effort in competing with each other. Federal law specifically recognizes the pooling of effort and of results in foreign trade as proper and desirable. The firms of the American aircraft industry compete in foreign markets against the industries of Great Britain, France, Germany, Italy and various lesser states. It is quite enough of a job to do that without having to work against each other at the same time. We believe that it would be definitely in the interest of the American industry to arrange for a definite pooling of foreign trade effort and income among the leading group of producers, at least for certain markets or in certain parts of the world. There is no present prospect of acceptance of any such measure of community of effort as would enable America to present a united front against Europe, but we continue to hold it among the most important planks in our platform, even though it happens to occupy the last place in our arrangement.

THAT leaves exposed what we consider a reasonable chart for 1933. By the beginning of 1934 no doubt the time will be ripe for a complete recasting of the whole structure of recommendation. There are urgent problems still before us, and some of them will still be there at the end of the present year. It is, however, a remarkable tribute to the increasing seriousness with which the aircraft industry has studied its own place in the world, analyzed its own problems, and attacked the task of finding a solution that out of almost 30 items which seemed important enough to be separately mentioned a year ago, more than a third can be considered as having been completely cleaned up during 1932, while at least two-thirds show substantial progress in the right direction. Perhaps there has been no previous year in which the industry has shown so marked an improvement in fundamental outlook, or so great a gain in the substitution of plain common sense for romantic impulse.

NEWS OF THE MONTH

More air mail hearings

OUTCOME of the latest air-mail hearings of the House Post Office Committee is the creation of a sub-committee to investigate the air-mail system from top to bottom. Appointed by Representative Mead of New York, chairman of the parent committee, the sub-committee will scrutinize rates, routes, and contracts on the airlines, as well as the recommendations of Dr. James Crane of Harvard University's School of Business Administration. Dr. Crane, who has been acting as special investigator for the Committee and who was principal witness at its hearings, suggests the reduction of the legal maximum rate of pay per mile to airline from $1.25 to 75 cents (this would be "whipping a dead horse," as the maximum actually paid to any line at present is 73 cents); reduction of air mail appropriation by $1,000,000 (to $18,000,000); cancellation of recent extensions of route and greater limitation on power of the Postmaster General to grant them in the future (a recommendation designed to check the creation of "political routes" of no economic significance); and the establishment of a scientific base rate for payment to operators, to be determined by a field audit of the accounts of contract airlines. He would extend to Pan American Airways the uniform rate and system of accounts applied to domestic carriers. Frederick E. Williamson, president of the New York Central Lines, goes much further, suggesting that airlines be grouped with inland waterways, highways and canals, which he would deprive of all government assistance. Mr. Williamson thus aligns himself among the railroad officials who seek to improve the position of their own enterprises by laying special handicaps upon all competition.

Top speed air service

Outstanding speed records for the new year have come in the course of regular air transport operation. United Air Lines' planes on Jan. 10 made a San Francisco-New York run in 16 hours 16 minutes flying time (22 hours 52 minutes total elapsed), two hours faster than the best 1932 record. An eighteen-passenger Boeing made the San Francisco-Chicago flight, a Wasp-powered Ford completed the trip to New York, incidentally in new record time of 4 hours 46 minutes (an average of 163 m.p.h.). Orchids, Artichokes, and other popular express items traveled from Los Angeles to New York in one of the Wasp-powered Lockhead Orions of Air Express, Inc., in 14 hours 20 minutes elapsed time. The Los Angeles-Wichita flight was made in 7 hours flat, the rest of the 2,600 miles from the coast to Floyd Bennett Field in 6 hours 10 minutes.

Regular transcontinental service for passengers, mail and express at these record speeds is planned by Transcontinental & Western Air for this summer. To fly a sixteen-hour schedule eastbound and eighteen hours westbound, 15 Northrop monoplanes of the Delta series have been ordered, the first to be delivered by March 1. Powered with 700-hp. Wright Cyclone engines, each will carry eight passengers, in addition to mail and express to bring the total load to 2,000 lb. The first Wasp-powered Boeing transport for United's new fast transcontinental run is scheduled for completion this month.

First airline penetration into Tennessee from the northeast will be made by the planes of Ludington Air Lines, which recently announced plans for a service between New York and Nashville on a nine-hour schedule. Three times weekly the 8 a.m. plane, out of New York will continue from Washington and Norfolk to Roanoke, follow the valley between the Great Smoky and Cumberland Mountains to Bristol, Va., stop at Knoxville, and reach Nashville at 5.35 p.m. Eastern Air Transport recently made an extensive survey of this territory, but has announced no plans for serving it.

American Airways move again

Coincident with its acquisition of Transamerican Airlines, American Airways is establishing executive offices at Chicago. The president of the line, whose offices were previously in New York, and 75 employees and executives form the operating headquarters established at St. Louis and Robertson, Mo., about six months ago, are chiefly affected. Its direct connection with every division of the system is the prime advantage of the new headquarters, which will be set up in the American Airways hangar at Chicago Airport.

Upon the removal of American Airways' offices to Chicago, R. C. Marshall, president of Transamerican Airlines recently acquired through stock purchases by E. L. Cord, was elected vice-president of American Airways. Mr. Marshall will be in charge of operations for the eastern territory, having under his direct supervision all the company's lines, including Transamerican, in the east and north central states. C. R. Smith, who has been vice-president in charge of operations for American Airways for some time, retains his title and will have charge of operations in the southern territory with headquarters at Dallas.

Air-rail cooperation

Joint tariffs, the first ever approved by a railroad association for combined rail and air tickets, have been arranged between the Trunk Line Association and the Southeastern Passenger Association, representing the railroads, and Pan American Airways System. Savings of about 30 per cent over all-air fare, and from one to four days travel time as compared with all-surface travel, are effected by the new tickets available between cities north of Washington and Havana, Nassau, Jamaica, and seven countries of the Caribbean region. The new low fares range from $110 for a round trip between New York and Nassau to $287 to the Panama Canal Zone and return.

All employees of the Pan American system, including flying as well as ground personnel, are covered by the group insurance being arranged through the Travelers Insurance Company. Totalling about three and a half million dollars, and placed by Parker & Company, aviation insurance brokers, it is the largest block of policies ever issued in the aviation industry.

In an effort to restrict the production of motion pictures which give the public an inaccurate and alarming impression of commercial air transport, the Aviation Committee of the Los Angeles Chamber of Commerce has drawn up a set of recommendations and warnings. Air transport operators, who have in several instances unwittingly lent their cooperation to the production of such films, are warned in some detail against giving any sort of assistance until the complete script for the picture has been seen and approved. The cooperation of the Motion Picture Producers Association has also been secured to facilitate the elimination of objectionable scenes before the release of the picture.

England-Australia air mail

Suggestions for the settlement of several issues which have been rending Australian civil aviation are offered in the report of the Inter-Departmental Committee on Australian Commercial Air Services. One recommendation, that Australia control and establish the Port Darwin-Singapore section of the projected England-Australia air mail services, has the full approval of the Commonwealth Government. With

some reservations, the proposals for the reorganization of Australian internal services are also accepted. Two main trunk routes following established routes around the edges of the continent are to converge at Port Darwin, in the north, nearest point to the islands of the Dutch East Indies. Proposed schedules provided for mail delivery in Brisbane, Sydney and Melbourne, queen cities of the southeast, on the 17th day out of London. Though the K.L.M. has requested the committee to reconsider its offer to operate the link service from India until the Imperial Airways service is ready for operation, acceptance is doubtful.

Intercontinental mail, again

More research into the practicality of airplanes for mail and passenger transportation over the South Atlantic and another step towards bridging the last gap in the all-air line between France and South America is the flight from St. Louis, Senegal to Natal, Brazil, made on Jan. 16 by M. Jean Mermoz. His tri-engined plywood monoplane whose designer, Rene Couzinet, was a passenger, covered the 1962 miles between the continents in fourteen hours. In addition to pilot and passenger, a second pilot, navigator, radio man and two mechanics were aboard. A fuel load of 219 gal. of gasoline and 66 gal. of oil and a load of mail brought the total weight to 3,130 lb. The machine was similar to the Couzinet monoplane recently flown from France to New Caledonia. Radio communication with the plane was maintained throughout the trip, which M. Mermo plans to repeat each month until the preliminary work for a regular air service has been completed. Similar aspirations were expressed after a previous flight by the same pilot over the same route, in the spring of 1930, but it proved impossible to realize them. Now, with better organization and better equipment, the French try again. This flight puts them one up in the competition to establish direct air communication with South America.

Sportsmen pilots go South

Center of the sportsmen pilots' universe in January was Miami, scene of the fifth annual Miami air races and goal of the second annual winter cruise of the U. S. Amateur Air Pilots' Association. Though only twenty planes took off from the Aviation Country Club Field at Hicksville, L. I., on Jan. 3, the official start of the cruise, 87 were at the post for the start of the Florida Year-Round Club Handicap Race from Daytona Beach, its climax. A trophy and $2,500 in cash had been donated by Henry L. Doherty, Cities Service magnate and enthusiastic winter Floridian, to go to the victors in a 240-mile cross-country race from Daytona Beach to Miami. Permanent possession of the trophy and $1,000 were won by J. Heron Crossman of Wilmington, N. C., whose time was two hours fourteen minutes. Raoul Cote came in six minutes later, and Edgar Woodhams took third place.

Outstanding feature of the Miami races was James R. Wedell's victory in the free-for-all event at 205 m.p.h., using the monoplane that he flew into second place in last year's Thompson Trophy Race. Roy Liggett, of Wichita, who an hour before had taken the E. H. R. Green Trophy race at an average speed of 194 m.p.h., coaxed another mile per hour from his Cessna to follow Wedell over the finish line. The new Beechcraft biplane, now on a demonstration flight through the eastern states, was flown by Eric Wood of New York to first place in the Texaco Trophy event at an average of 163 m.p.h for five laps of a five-mile closed course. The Beechcraft was the only machine to play a very prominent part at Miami which had not been seen at Cleveland last September.

In accordance with the decision of the Board of Governors of the Aeronautical Chamber of Commerce (AVIATION, January) that an aircraft show would be impractical in 1933, the Detroit Board of Commerce has formally withdrawn its suggestions that it be held there. The status of the 1933 National Air Races and the willingness of Cleveland to cooperate in holding them remains a matter of doubt.

Aeronautical scientists meet

With a Founders' Meeting and scientific symposium, in which stratosphere-sounding Professor Auguste Piccard takes part, the recently created Institute of the Aeronautical Sciences gets under way on January 26 at Columbia University. Various scientific and engineering problems of aeronautics are being discussed. A lecture by Professor Piccard closes the day. The first Honorary Fellowship of the Institute of the Aeronautical Sciences, reserved for persons of preeminence in aeronautics and to be awarded at most only once each year, has been accepted by Mr. Orville Wright.

Autogiros in new fields

Strange shadows will soon move over the Japanese countryside—two Kellett autogiros. Through its Japanese representative, Okura & Company, the Kellett Autogiro Corporation has been awarded a contract for two of its K-3 machines by the Japanese Government. Powered with 210 hp. Kinner engines and equipped with cabin tops, these autogiros will be the first of their type seen in Japan, or for that matter anywhere in the Orient. Another model K-3 is on its way to the company's representative in the Argentine, the third Kellett to invade the South American scene, where a short time ago the autogiro was entirely unknown.

Fleets for China

The Orient and South America are also the destination of planes from the Consolidated Aircraft Corporation's factory. Fifteen Model 10 Fleets have been ordered by the Central Aviation Bureau of the Chinese Government. Totalling about $60,000, this is the second order for fifteen planes received

GIVING THE LAYMAN THE INSIDE STORY

Magnetos, propellers and a Curtiss Challenger populate this corner of the Newark Museum where displays from 90 commercial and research organizations present the historical, industrial and engineering aspects of aviation to the public.

from the Chinese government since last June, when an unofficial American mission arrived to help modernize Chinese aeronautical affairs. Destined for training use, these fleets are refinements of the Model 7, and carry 125 hp. Kinner engines. Meanwhile, the Japanese bombers which rained destruction on Shanghai last spring have been transferred to Jehol, province of northeastern China. There, they give almost daily proof that they have lost nothing of their merciless efficiency.

The Republic of Colombia, now in difficulties with Peru over the territory of Leticia, is purchaser of a large long-range flying boat from the Consolidated company. Powered with two geared Wright Cyclone engines of 700 hp. each, its cruising speed is in excess of 100 miles an hour. Tankage for 1,200 gallons of gasoline gives the big plane a range of about 1,000 miles without refueling. It was assembled on Long Island, where test flights were made, and is now being ferried to its new home.

American engines on the Continent

Most recent foreign penetration of the Curtiss-Wright Corporation has been on the European continent. Whirlwind engines of 365 hp. power the A.N.T-9 trimotor planes recently ordered from the aircraft factories of the U.S.S.R. by Deruluft, joint German-Russian airline. Two of the new transports have been placed in service on the Berlin-Moscow route. Four are still under construction, to be delivered shortly. Of all-metal construction and similar in external appearance to the Ford trimotors, except that the outboard engines are mounted in the leading edge of the wing, the A.N.T.-9 carries ten passengers and a crew of two at a cruising speed of 125 miles per hour.

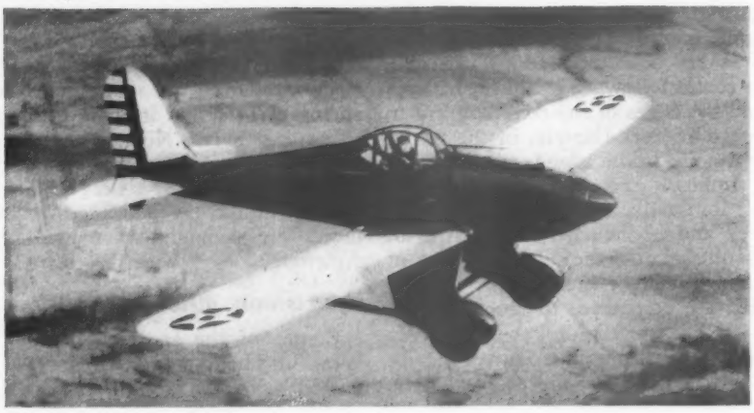
A Wright engine is the first of American design to receive an airworthiness certificate from the British Air Ministry. Granted to Canadian-Wright, Ltd., of Montreal, agents in the British Empire for the Wright Aeronautical Corporation, it approves the nine-cylinder Whirlwind for a rating of 300 hp. at 2,000 r.p.m. The engine, which has undergone tests in the laboratories of the Aeronautical Division of the National Research Council of Canada is practically identical with the model recently rated by the U. S. Department of Commerce at 330 hp.

Beechcraft approved

An approved type certificate has been issued by the Department of Commerce to the Beechcraft 17R. The Beech Aircraft Company of Wichita, Kan., expects to go into production immediately on this model (described on page 488 of the December, 1932, issue), the first example of which recently won the Texaco Trophy race at Miami.

Arrangements completed with the Century of Progress organization grant to Pal-Waukee Airport, Chicago North Shore suburban field specializing in the interests of private owners, exclusive concession for the operation of all heavier-than-air craft except autogiros during the period of the Chicago World's Fair next summer. Space limitations make the landing of landplanes within the fair-grounds proper impractical. The space allotted to the concession is along the lake front, and will provide for a seaplane and amphibion base. Providing service facilities for visiting aircraft, the Pal-Waukee management will also operate shuttle planes to Chicago Municipal Airport to connect directly with nation-wide air transport systems. Probably the outstanding activity of the concessionnaire will be providing for sightseeing flights over the fair-grounds. Ten-passenger twin-engined Sikorsky amphibions will be used for both services.

A new Service Information Bureau has been opened by the Nicholas-Beazley Airplane Company in connection with its eastern branch at Floyd Bennett Field. Service and flying organizations may obtain first-hand information regarding the cost of material necessary to complete specified overhaul and repair work on any type of plane.



ANOTHER CURTISS PURSUIT FOR THE ARMY

Powered with a 650-hp. Curtiss Conqueror V-1570 liquid-cooled engine, the XP-934 is undergoing performance testing at Wright Field. It is the first Army pursuit plane to be equipped with automatic slots and flaps. These may be locked in any position by the pilot.

Again Detroit Aircraft

Only the formality of a Federal Court approval remains to put the name Detroit Aircraft Corporation back on the list of aircraft manufacturers. A plan for reorganization of the company, which has been in receivership since last spring, was unanimously approved by the stockholders at a special meeting in Detroit on Dec. 29. A new corporation under the old name will be organized to purchase at a judicial sale the assets of the old company. It will have authorized capital stock of 200,000 shares of one dollar par value, to be offered in the ratio of one new share for each ten shares of old stock, of which 1,104,131 shares are outstanding. Chief engineer of the new company will be William B. Mayo, formerly chief engineer of the Aircraft Division of Ford Motor Company. Peter R. Beasley, who was president and in charge of operations of Detroit Aircraft for the last twelve months before its receivership, and devised the reorganization plan, will be general manager.

New Navy planes

Among recent arrivals at the U. S. Naval Air Station at Anacostia, were a Great Lakes scout plane designated XSG-1, and a fighter from the Buffalo plant of Curtiss Aeroplane & Motor. The Great Lakes Scout, ferried in from Cleveland, is an amphibion biplane with supercharged Wasp Junior engine. Like the Loening scout amphibion delivered and demonstrated some weeks ago, the XSG-1 has transparent panels providing weather protection for the observer. Its wings can be folded back and secured to the hull for storage on cruiser or submarine. The Curtiss fighter, with Wright R-1510 two-row radial engine, is undergoing service acceptance trials by the Board of Inspection and Survey.

Twenty-seven two-seater fighters, based on the XFF-1 which has been undergoing service testing for some time past, have been ordered from the Grumman Aircraft Engineering Corporation by the Navy Department. First deliveries are scheduled for June. This is the first production order of the Grumman company, which recently took over the erstwhile American Airplane & Engine plant at Framingdale, L. I.

Under the contract recently awarded to the Standard Oil Company (Kentucky), Stanavo distributor in Florida, 1,318,000 gallons of Stanavo gasoline will be distributed to eleven naval air

stations between New Jersey and Florida. Gasoline to be supplied is largely Stanavo Aviation Gasoline conforming to Navy specifications for 73 octane fuel (60,000 gallons are Stanavo with Ethyl, octance rating, 87).

Marines take a trophy

To a Marine Squadron goes top score for safe naval flying. Marine Fighting Plane Squadron 10-M flew 1,862.25 hours without accident during the fiscal year 1931-32, winning the Herbert Schiff Memorial Trophy. A part of the West Coast Expeditionary Force based at San Diego, Cal., Squadron 10-M consists of six F6C-4 Curtiss fighting planes. The trophy, presented to the Navy Department in 1925, and for the first few years awarded to an individual pilot, since 1929 has gone to squadron or unit making the best safety record. Only previous Marine victory came in the days of individual awards, when Capt. H. D. Campbell was a winner. Fighting Plane Squadron 3, attached to the U.S.S. Langley, received the award in 1930 for 4,958 hours, while last year it went to the U. S. Naval Reserve Aviation Base at Floyd Bennett Field for a score of 3,441 hours without accident. Reduction in personnel and in individual flying time allowance is responsible for the steady drop in record totals of flying hours.

Germany's new airship

Early in the summer the world's-largest-airship title will pass to the LZ-129, now nearing completion at Friedrichshafen, Germany. The new airship is a bare eight feet longer than the Akron, present title holder, and 37 ft. longer than the Graf Zeppelin. Its passenger accommodations will be considerably more spacious than those on the Graf, and will be entirely separated from the navigation rooms. Four Diesel engines of 1,000 hp. each propel it. Both the Maybach and M.A.N. firms are building engines, and only after tests will it be decided which type will be used in the LZ-129. Use of diesel engines effects a saving in fuel consumption sufficient to allow an increase of about half a ton in useful load on the voyage from Europe to South America.

CAPTAIN HUGH M. ELMENDORF, of the training and operation section, Office of the Chief of the Air Corps, was killed on Jan. 13 when the pursuit plane which he was testing crashed in a spin near Byron, Ohio. Recognized throughout the Air Corps, with which he had been connected since the War, as one of its leading technical officers, he was known especially for his study of high altitude fighters.

French Navy recaptures aviation

The severest blow which the French Air Ministry has had to sustain since its creation is the loss of control over naval aviation. The French Navy, like all other navies, is hotly opposed to separate air forces. Under Paul Painleve, mathematician and head of the present Air Ministry, a struggle which has been going on since September, 1928, when the Ministry of Air was first set up, has been terminated. The Navy wins, regaining control over practically all its aeronautical activities with the exception of manufacture and experimental work in airplane design. Since a Ministry of Air is not only included in the new government under Premier Paul-Bocour, but M. Paul Painleve is returned to his old post at its head, the fears of the French press that the final disintegration of the Air Ministry is at hand seem unfounded. No change in the handling of land-based aviation is involved. In France as in the United States and most other countries, the Army is much less hostile to the idea of a separate aeronautical organization than is the Navy.

Germany's aeronautical exchequer

Probably unique among treasury reports for the current fiscal year is that of Germany, which represents a slight enlargement of appropriations over the estimates of the previous year. Though the total estimates for the fiscal year ending March 31, 1933, show only a slight increase, some items, notably that for "economic promotion of the German aeronautics industry" or subsidies for manufacturers, are up more than 50 per cent. The transport subsidy to Deutsche Lufthansa, though still the biggest item on the books, is about a million and a half marks, or 8 per cent, below the previous year's figure. A reduction of some 300,000 marks is made in the allotment to the German Aeronautics Research Institute at Adlershof, which handles the testing equipment and research work.

Blind landings by Lufthansa

In connection with the opening of a training school for pilots at Tempelhof Aerodrome in Berlin a system for blind landings recently developed by the Lufthansa was demonstrated. Radio devices guided a pilot in the closed cabin of a tri-motored transport to the proper point from which a landing could be made, assuming a clear ceiling of only 200 ft. American accomplishment in the way of blind landing has already gone much farther than that. Somewhat similar methods were used by Capt. Albert F. Hegenberger last summer in blind landing tests in which he was alone in the plane, with its cockpit completely hooded. New landing beams soon to be installed by the Department of Commerce not only guide the pilot to the field, but give him a directional angle of glide to follow directly to the ground, regardless of visibility.

Personnel

Capt. George W. Steele, commanding officer of the aircraft carrier Saratoga, was relieved of his command on December 31 to permit his retirement after 30 years of active service. First commanding officer of the Los Angeles, he was of the first group of American naval officers to make a flight across the Atlantic in a rigid airship. He came over in the Los Angeles when a German crew delivered her to Lakehurst. Capt. Rufus F. Zogbaum, commander of the Naval Air Station at Pensacola, will take over his command.

Comdr. Fred T. Berry, now executive officer of the Naval Air Station at Lakehurst, N. J., is taking command of the Rigid Airship Training and Experimental Squadron of the U.S.S. Akron, and also of the Lakehurst air station. Lt. Comdr. Jesse L. Kenworth, Jr., succeeds him as executive officer of the station.

Air Chief Marshal Sir John Salmond, retiring Chief of Staff of the Air Ministry, will succeed Air Vice-Marshal Sir Vyell Vyvyan in April as government director on the board of the Imperial Airways. Upon his retirement from the Air Force, announced last July (AVIATION, September, 1932) but just about to take effect, Sir John will be succeeded by his elder brother, Air Marshal Sir Geoffrey Salmond.

With the completion of reconstruction work at the Aeronautical Research Institute of the Tokyo Imperial University Dr. C. Shiba, who has been promoting this work for the past nine years, has announced his resignation as director. Dr. Koroku Wada, professor of the Imperial University and aerodynamicist of international repute, has been appointed his successor.

F. Trubee Davison, Assistant Secretary of War in Charge of Aeronautics, has been elected president of the American Museum of Natural History to succeed Prof. Henry Fairfield Osborn. On March 3 Mr. Davison will resign the post to which he was appointed by the late President Coolidge in 1926, to give his full time to his new duties.

Major Jack Berry, manager of Cleveland Airport since 1926, has tendered his resignation, to take effect immediately. Claude F. King will be acting manager until permanent appointment can be made.

E. K. Campbell, long associated with Curtiss-Wright in various capacities, has been apointed manager of sales and service in the Transport Division of the Curtiss-Wright Airplane Company.

FLYING EQUIPMENT

The new Condor transport

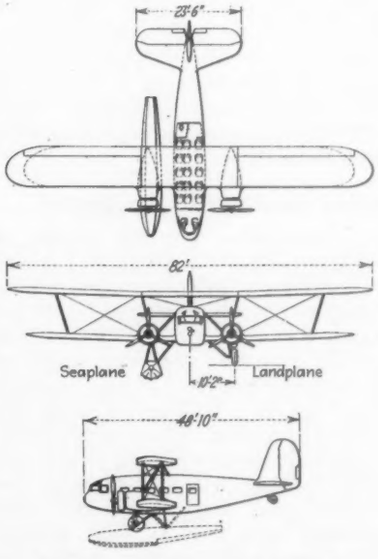
Photograph of a model showing appearance of the new Condor in flight.

THE new Curtiss-Wright Condor transport for 1933 (nine of which are under construction at the Robertson plant), now three generations removed from the Army's heavy bomber of 1927, has shaken off all the earmarks of its military ancestry. Up to this point the transition has been gradual. The first change involved alteration in fuselage dimensions, to provide cabin room, fairing over of gun cockpits in the nacelles, and the introduction of dihedral to improve lateral and directional stability. The second or intermediate stage left the primary structure basically unaltered, but was concerned chiefly with a general streamlining and cleaning up of the exterior (including complete revision of nacelle shapes) and, more important still, the building in of certain features to improve maintenance facilities, and to lower operating costs. The 1933 model, the third step, is a decided variant,—a new off-shoot on the Condor family tree. Completely redesigned, it is a purely commercial type built to meet modern air transportation requirements. Except that it is a biplane with two engines carried outboard in the lower wing panels, and that it incorporates maintenance and passenger comfort features painstakingly developed during the past two years of active service on Eastern Air Transport, Inc., the resemblance to the older models is not very pronounced.

Externally, the most obvious changes concern the power plant, the landing gear, and the tail surfaces. The first is probably the most significant. Since its inception, the Condor, — bomber and transport,—has been built around the water-cooled Curtiss Conqueror engine. The underlying reason was probably a desire to concentrate all the power in two units which, until the relatively recent entrance of air-cooled engines into the higher horsepower ranges, precluded their use. Two of the newest Cyclone F's of 700 hp. each are used on the new Condor. Geared models were selected to reduce propeller tip speed (and therefore, propeller noise), and to increase propulsive efficiency. Large diameter three-bladed metal propellers are fitted. The engines are mounted in streamlined nacelles of the N.A.C.A. type, located in accordance with the latest recommendations from Langley Field, with propellers in line with, and well ahead of the leading edge of the lower wing. This puts the plane of rotation well ahead of the passenger compartment, an important point with respect to cabin noise and passenger safety.

An extremely simple gravity type fuel system, said to contain only 18 fittings, has been laid out for the ship. The gasoline is carried in four 75-gal. tanks in the center section of the upper wing, and is fed by gravity down to the carburetors. Fuel may be used from any tank to either engine, and the filler openings have been manifolded to simplify fueling operations.

Modern high-speed transport requirements call for retracting landing gears (for a general discussion of the economics of landing gears see page 33 this issue), and the new Condor is not lacking in this respect. The main wheels are located below each engine, and may be withdrawn in flight into the underpart of the nacelle. The retraction is not complete, as about one-half the diameter of each wheel remains exposed to the slip-stream. All axles and bracing struts, however, are completely housed. Normally the retracting mechanism is operated electrically, but for emergencies hand-operated mechanical control is provided. Three separate warning devices are installed to indicate the position of the gear to the pilot. The tires are of the low-pressure safety tread type, and the wheels are fitted with mechanical brakes. The tail-wheel is not retractable, but is furnished with streamlined fairings. As shown in the accompanying three-view drawing, the machine may be fitted up as a seaplane by the installation of Edo twin-floats in place of the wheeled gear.



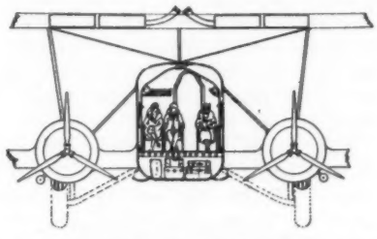
General arrangement showing optional wheels or floats

One of the distinguishing marks of the old Condor was its biplane tail and double rudder. These features have been eliminated in the new machine by the substitution of the more conventional single horizontal and vertical tail surfaces. The old idea that the control surfaces of the tail must be kept in the slip-streams of multiple power plants has been generally abandoned. On the new Condor both the vertical and horizontal surfaces are of high aspect ratio, as dictated by current practice. It is of interest to note that servo surfaces of the Flettner type have been incorporated, both in the rudder and in the elevators. Dynamic balancing of the offset hinge type has also been used, and all removable surfaces are hung on ball bearings, both for ease of control and for reduced maintenance costs.

With respect to structure, the new ship is of the conventional composite type. The fuselage is welded up from chrome-molybdenum steel tubing. Wing beams are of heat-treated welded steel, and the ribs of duralumin. All surfaces and the major portion of the fuselage are covered with doped fabric. A great deal of attention has been paid to the accessibility of the interior structure by the proper location of removable panels and inspection windows. The same is

true of the cowl layouts. Every essential part of power-plant or controls may be reached for inspection in a minimum time. Electric wiring throughout the ship is run in metal conduit with shielded junction and fuse boxes.

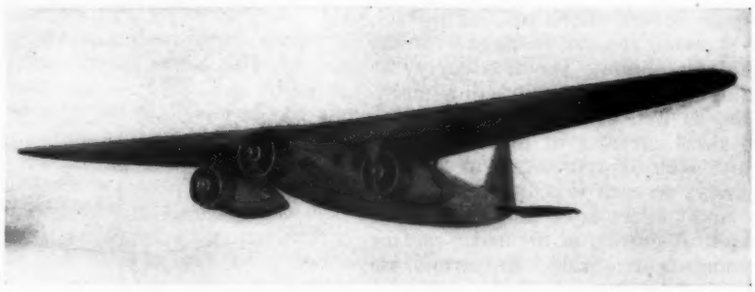
The pilot's compartment in the nose is fitted with the full complement of blind flying instruments, all rubber mounted. Radio transmitting and receiving apparatus is to be placed in the cockpit behind the pilots' seats. As in previous models, the dual controls are fitted on a Y support from a single column mounted between the seats. The passenger cabin is fitted with seats for fifteen persons, arranged in a single row along one side, and a double row along the other, with an aisle between. The cabin is not subdivided into compartments as was done in the last ship purchased by Eastern Air Transport. Normally all seats face forward, but some of the chairs may be reversed if desired. The interior is finished in a combination of fabric and leather with linoleum-covered floors. Radius pieces



Cross section of Condor showing seating arrangements, disposition of baggage, fuel tanks, etc.

are provided at the bottom of the wall to eliminate sharp corners, and the floor linoleum extends a short distance up the wall. This feature, together with flush type door sills permit easy cleaning, and prevents the accumulation of dirt in corners. The windows are of laminated glass and cannot be opened. Cabin ventilation and heating are supplied from a central system. The general control is in the hands of the pilot, but individual outlets permit each passenger to adjust the warmth or the air supply at his seat to suit his fancy. Since no gasoline is carried in the fuselage proper, the possibility of fumes from this source is entirely eliminated. Great care has been expended in insulating the walls. The cabin is virtually an inner fuselage shell, separated from the outer shell by large air spaces and suitable sound-proof padding.

The new Condor has a wing span of 82 ft. and a gross weight of somewhat over 16,000 lb. of which 3,200 lb. is available as pay-load. It is expected to show a high speed of about 170 miles an hour, and a cruising rate of about 145 miles an hour. Its normal fuel capacity of 300 gallons gives it a possible range of about 560 miles.



A Fokker F-XX transport as it appears with landing gear retracted.

Fokker builds high-speed transports

THE active development of a number of highspeed transport designs by the Dutch Fokker Company (of which the first unit will go into service shortly on K.L.M.) warrants the assumption that European operators are no longer content with 100-mile an hour cruising speeds, but have been attracted to the possible economies of the 150-200 m.p.h. range now being invaded by their American contemporaries. First to be delivered will be a three-engineed monoplane designed for long-range work with 12 to 20 passengers at a cruising speed of 155 m.p.h. Top speed of 183 m.p.h. is predicted. This model can take engines ranging from 500 to 800 hp. each. The first machines are being fitted with three 700 hp. Wright Cyclone F's.

In general arrangement the F-XX is typically Fokker, but exhibits a number of innovations. The standard welded steel tube, fabric-covered fuselage has been retained, although the old rectangular cross section has been changed in favor of an approximately elliptical form. Outboard engine nacelles have been dropped well below the wing, and are supported entirely from the wing structure, there being no bracing members across to the fuselage. The landing gear is attached to the nacelles only, and is completely retractable. The main wheels can be pulled up into the nacelles and the openings completely covered with sliding panels. The tail wheel may also be entirely withdrawn into the fuselage. N.A.C.A. cowlings are fitted on all three engines.

Depending on the range desired, the cabin can be arranged for 12 or 20 passengers. Some 210 cu.ft. of baggage space is available, distributed between the fuselage and several wing compartments some of which are located between the main spars, and others aft of the rear spar in the trailing edge of the wing.

A number of other machines are in various design and construction stages. The F-36, a four-engined (Cyclones) monoplane for long range work with alternate cabin arrangements—one with chairs for 32 day passengers, and the other with convertible sleeping accommodations for 16 day and night passengers—has also been ordered by K.L.M. Besides these, there are under way a smaller high-speed trimotor for 10 passengers; a high-speed single-engined transport for mail, or 8 passengers; and a twin-engined design about which very little is known to date.

General Aviation's Clark GA-43 transport

A BID for economy through simplified maintenance and high cruising speed is being made by the Clark designed GA-43 transport by General Aviation Manufacturing Corporation.

The new machine is a low-wing monoplane, with a full metal monocoque fuselage, fitted with retracting landing gear. It is powered with a single Wright Cyclone E or F (P & W Hornet may also be used), and has seats for ten passengers and a pilot.

View from pilot's seat—GA-43.

The metal monocoque fuselage has a smooth skin of Alclad, rivetted to Z-bar stringers, supported on built-up duralumin ring-type bulkheads. Wing stubs extend about 3 ft. beyond, and are an integral part of the fuselage. The principal stresses are carried on two duralumin lattice type beams with certain stainless steel fittings, which carry the loads across the fuselage through the bulkheads. The stubs

perform several functions. They not only provide attachment points for the main wing beams, but also carry the landing gear and its retracting mechanism, as well as the main fuel tanks. The metal covering of the top surface of the stub is reinforced to provide walkways on each side to give access to the tank filler caps and the pilot's cockpit. A portion of the under-surface covering is removable to permit the inspection or removal of the tanks.

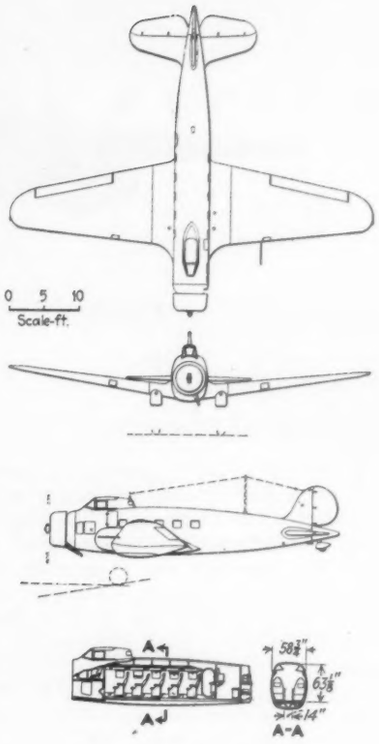
Probably the most interesting part of the stub assembly is the attached landing gear and its retracting mechanism. Goodyear 30x13 air-wheels are used, as well as oleo-spring shock absorber struts. The construction of the gear is described on page 36. The retracting mechanisms on both sides are attached through a "Y" connection to a two-way valve and a hand-operated oil pump in the cockpit. It is claimed that the gear may be retracted in 18 seconds, extended in 7.

The wheels retract into streamlined housings which extend below the lower surface of the stub. The nose, sides and tail pieces of the housing are fixed, but the bottom portion is in the form of a pair of clam-shell type doors which are automatically opened by the landing gear as it is extended. When the gear is retracted, the trap doors snap shut to form completely covered streamline enclosures.

The moving parts of the undercarriage are carried on large hardened steel pins through generous removable bronze bushings provided with pressure type lubrication. With the airplane on the ground in landing position, all parts of the wheel retracting mechanism are completely accessible, for the wells into which the wheels are drawn are large enough, and give sufficient headroom to permit a man to stand upright and work inside comfortably. The wells are also completely closed off from the rest of the wing structure so that it is possible to hose out any accumulation of mud or dirt.

The wings are of the full cantilever type, tapered both in thickness and in chord, and are fastened to the wing stubs through forged steel pin-type fittings. These fittings are accessible by the removal of a covering strip held on under turnbuckle tension. The main wing beams are latticed duralumin tubing. Ribs are of smaller diameter dural tubing on a modified Warren truss pattern. The wing tips are elliptical, and the ailerons, which are of the balanced type, are inset.

Aside from the obvious efforts to reduce drag through careful streamlining, the airplane exhibits one or two other aerodynamic features worthy of comment. As a result of extensive wind tunnel tests for lateral stability the final design shows 6 deg. of dihedral on each wing, an abnormally



Clark GA-43 monoplane.

high value for monoplanes of this type. Another unusual feature is the use of a short fixed slot in the leading edge of the wing opposite a portion of the ailerons. The slotted part of the wing is very short (not over 30 to 36 in. in length). It is located opposite the inboard one-third point in the length of the ailerons. The nose airfoil, or slat, is in line with and is an integral part of the leading edge of the wing. Its cross-section, and dimensions of the slot are those developed recently by the N.A.C.A. for the Clark Y wing. This combination is said to be effective in improving aileron control at or near the stalling point.

A number of interesting maintenance features have been incorporated. For example, the fuselage at the tail is deep enough where the stabilizer front spar passes through to permit a man to work comfortably around the adjustable stabilizer mechanism. The tail cone may also be removed making the entire assembly open for visual inspection. All piping and wiring underneath the pilot's cockpit is completely accessible from the forward baggage compartment. The control wiring leading from the cockpit to the tail surfaces can also be laid completely open for inspection and adjustment by lifting sections of the floor along the cabin aisle. Large inspection plates are provided along the wings so that aileron cables may be reached along their entire length.

The cowling around the engine, which is of the full N.A.C.A. type, can be removed in full or opened up in part, as it is constructed in three sections hinged at the top and at the lower right side, and fastened together on the lower left side by means of a pair of internal turnbuckles. When the turnbuckles are loosened there is no tendency for the cowl to drop off as it hangs over the upper half of the engine.

The pilot's cockpit is located high in the nose of the fuselage, and is surrounded with a dural cab. The front and side panels are of shatterproof glass, and the roof is strong enough to protect the pilot in the remote event of the ship capsizing on the ground. The center section of the housing slides backward over the rear portion to open up the whole cockpit for ordinary or emergency entrance or exit. The cockpit is high enough above the fuselage so that with the plane in flying position on the ground the pilot can see over the cowling to within about 50 ft. of the nose. (See preceding page.)

The stabilizer control is beside the seat on the left side, and the valve and pump for the retracting gear in a similar location on the right. The throttle and mixture controls are set in the usual way under the pilot's left hand, and the electrical control panels are mounted in the side wall just forward of the throttle. This panel takes care of both the radio and all lights.

The main instrument panels are divided according to function. In the center, at the top of the instrument board is a complete navigating panel with engine instruments and the brake hydraulic system indicating instruments on sub-panels immediately below. The back of all panels can be reached by removing a small section of the cowling ahead of the windshield. All instruments may thus be conveniently disconnected, and each unit panel removed by loosening a few screws from the front.

A pair of slide-type indicators, one on each side wall, indicates the position of the retracting undercarriage, each wheel being indicated independently through a Bowden type connection. A novel indicating device has been installed to warn the pilot in case he attempts a landing without letting the wheels down. A miniature electric motor is clamped to the lower part of the control stick with its axle vertical and parallel to the stick. A small aluminum disk or flywheel is attached to the motor shaft, and the flywheel is unbalanced by attaching a small piece of lead to one side. If the motor is rotated the unbalanced flywheel imparts a sharp vibration to the control stick, which cannot be overlooked. Current is drawn from the plane's storage battery, but the circuit includes three small switches in series, all of which must be closed to start the motor. Two of them are mounted on the undercarriage and the third is attached to the throttle. Thus when the latter is closed

with the wheels up, the stick starts to vibrate.

Another simple but useful detail in the cockpit is a stick-locking device. A small V-shaped bracket is hinged to the bottom edge of the instrument board. With the stick centered in an upright position, the bracket may be so swung that a pin at its free end drops into an eye fastened to the stick and thus prevents any control motion.

Cabin chairs of welded dural tubing are of the adjustable reclining type, and are spaced so that there is plenty of leg room available. Overhead baggage racks run the full length of the cabin. Emergency communication with the pilot is possible through a small sliding glass window forward. A well-equipped toilet compartment occupies the usual location aft of the cabin. The main entrance door is in the starboard side behind the wing, and an emergency exit is forward on the port side.

Unusual pains have been taken to achieve quiet in the cabin, both by the elimination of direct sound waves, and vibration carried through the structure. Between the outer shell of the fuselage and the inner paneling of the cabin is a layer about 1 in. thick of a mixture of about 80 per cent down and 20 per cent feathers. The windows are double $\frac{3}{32}$-in. Triplex safety glass set in sponge rubber with about $\frac{1}{2}$ in. of air space between panes. They cannot be opened. Light roller type shades are part of the standard equipment.

A complete cabin heating and ventilating scheme has been worked out, in which cold fresh air is collected through a screened port in the leading edge of the wing stubs on each side, and is distributed through an aluminum duct fastened to the wall over the windows on each side. Small swiveling nozzles of a novel type permit each passenger to direct the incoming stream of fresh air as he may see fit. Air to be heated is carried through a small boiler system under the control of the pilot and distributed through ducts in the side walls below the seats on each side. Registers at each seat permit the passenger to adjust the amount of warm air desired.

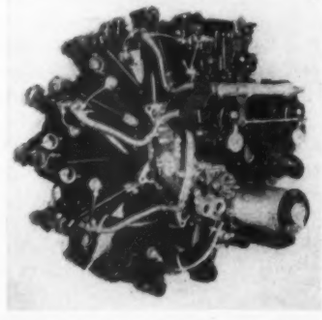
Engine vibration has been materially reduced by using rubber washers in the engine mount connections and between the engine and the mount. All cowlings around the nose are so attached that there is no solid metal between engine and fuselage to transmit vibration. Even the exhaust tail pipe is supported at its outer end through a ball and socket universal joint coupling. With such precautions against direct vibration, and with the unusual wall insulation installed, this airplane is said to be so quiet that conversation may be carried on from front to rear of the cabin without raising the voice.

The general arrangement of the airplane is found in the accompanying three-view drawing. The weight of the airplane structure complete, including engine, equipment, etc., and built-in radio mounting is 4,921 lb. Allowing for a pilot at 170 lb., and fuel, oil and payload (not including radio and flares) at 2,909 lb., the total gross weight comes to 8,000 lb. In carrying 96 gal. of gasoline and 8 gal. of oil (no radio or flares) the payload is 2,273 lb. With 136 gal. of gasoline and 11 gal. of oil (no radio or flares), the payload amounts to 2,010 lb. For the addition of radio installation (complete two-way) and for two flares deduct 200 lb. and 40 lb. respectively from the above payload figures.

Wright double-row radial engine

MENTION was made on page 25 of the January, 1933, issue of AVIATION of the Wright fourteen-cylinder two-row Whirlwind Model R-1510 engine, installed in the special Northrop monoplane for Commander Frank Hawks. This engine has been undergoing flight and block tests by the manufacturer and the U. S. Navy over a period of some eighteen months. With its two staggered banks of seven cylinders each, it is virtually a combination of two Whirlwinds placed back to back and operating on a single crankshaft. Although the 5-in. bore and 5.5-in. stroke of the Model R-1510 gives each bank a displacement equivalent to the standard 280-hp. Whirlwind, the twin-row arrangement with twice the displacement develops almost three times the power with no increase in frontal area.

The engine in the Hawks ship is a geared model, capable of developing 700 hp. at 2,300 r.p.m. for full throttle at sea-level. Its dry weight including the reduction gear and standard equipment is 870 lb., giving a specific weight of 1.24 lb. per hp. Direct drive models weigh some 45 lb. less, and yield a figure of 1.17 lb. per. hp.



Three-quarter rear view of Wright Model R-1510 fourteen-cylinder two-row engine. Note the resemblance in rear crankcase and accessory mountings to the Model F Cyclone.

Although the dimensions of the various units in the engine are closely related to the Whirlwinds, the design in general exhibits all the recent improvements incorporated in the latest Cyclone series (see AVIATION, December, 1932),—including new cylinder head finning, built-in spark plug coolers, and the large diameter, low-speed blower impeller.

The crankcase is composed of seven sections of heat-treated light-metal alloys. The nose section is an aluminum-alloy casting carrying the valve tappet guides and the front cover plates. The main case (heat-treated aluminum-alloy forgings) is in three sections. The center section contains half of the cylinder pads for the front and rear rows of cylinders, while the front and rear sections are identical and complete the cylinder support pads. Through-bolts between the cylinders hold these sections together. The rear sections of the case containing supercharger and accessories are practically the same type as those of the Cyclone Model F. The super-charger blower is 11 in. in diameter, and operates at a comparatively slow speed, thus reducing stresses on bearings and increasing efficiency of the supercharger unit as a whole. A down-draft carburetor is standard equipment. All the power driven accessories are mounted on the rear cover, which is in the form of a flat plate. These include two Scintilla 14-cylinder magnetos, oil and fuel pumps, Cuno oil strainer, and oil pressure relief valve. Mounting flanges are also provided for starter, two tachometers, generator and drives for two machine-gun synchronizers.

The crankshaft is a one-piece steel forging with two throws set 180 deg. apart. It is carried on one ball and three roller bearings, and is balanced by two counter weights. Master rods are of a patented "banjo" type. Split core pieces which carry steel backed bronze bearings are fitted into the banjo ring and secured by clamping bolts. Link rods are forked at the knuckle pin end, and are pinned to the master rod core pieces. Bronze bushings are used throughout.

A double oil pump assembly is used, consisting of one scavenging and one pressure pump, both mounted on the accessory section. Oil for the main bearings is introduced into the rear end of the crankshaft under pressure, and excess oil from all parts of the engine drains into a sump attached to the nose-piece and mounting sections, and is returned to the main tank by the scavenging pump after passing through the strainer.

The general specifications of this engine, other than those mentioned above are as follows: displacement 1,510 cu.in.; compression ratio 6.25:1; reduction gear ratio 8:5; overall diameter 45 in.; center of gravity 1$\frac{1}{16}$ in. forward of the center line of the rear bank of cylinders.

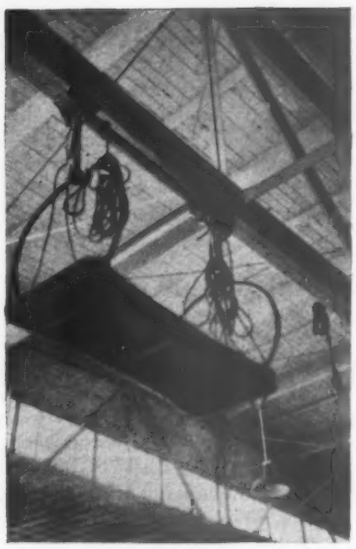
SERVICING SHORT CUTS

Open wider, please!

THE aircraft industry has always felt free to borrow tools or methods from the older arts wherever suitable applications could be found. Recently mechanics in United Air Lines' shops at Chicago have turned to the field of dentistry for assistance in checking up on the condition of metal propellers. It has been found that an ordinary small-sized dental mirror with its offset handle is an ideal tool for the examination of propeller hubs and clamping bolts. The engine side of the hub, which is ordinarily difficult to inspect at close range, is thereby made completely accessible for detailed inspection.

Overhead for profit

IN many shop operations, "overhead" items are frequently linked-up with financial losses. Somewhat more literally, the Cheyenne, Wyo., shops of United Air Lines have installed an overhead item which actually reduces costs. The upper surfaces of the top wings of the Boeing 80A's used on the Chicago-San Francisco run and based at Cheyenne, are very high above the ground and are therefore difficult of access for inspection and repair. To go over these surfaces with the help of step-ladders and scaffolding, was awkward and expensive, but advantage has been taken of the heavy I-beam track hanging from the roof trusses of the main servicing hangar (for the hoisting and moving of engines and other heavy parts) to do such jobs from a sort of overgrown bosun's chair suspended from the rail on a pair of trolleys. Rope slings permit the adjusting of the platform to any desired level, from which a mechanic may easily and quickly inspect the entire top wing of an airplane placed below the hoist rail. Minor repairs such as patching fabric, can thus be conveniently carried out, as well as a touch-up, or doping of the entire top surface. An extension light, provided with an automatic cord reel is mounted on the I-beam within reach of the mechanic in the bosun's chair.



Aviation

"Under the big top." Mechanics "trapeze" for servicing the upper wings of Boeing 80-As at Cheyenne.

The ship-cleaner's locker at the Brownsville base at Pan American Airways.

Aid to good shipkeeping

FEW transport airplanes leave the hands of their servicing crews cleaned and polished to the degree of those which fly south to Mexico City and the Canal Zone out of Pan American Airways base at Brownsville, Tex. (See page 40, this issue.) The extent to which the clean-up work is organized is indicated by the ship-cleaner's locker illustrated in an accompanying photograph. The cabinet is about 6 ft. high, 3 ft. square, and is mounted on swivel casters so that it can be moved about the servicing hangar floor. When cleaning the interior of a plane the open cabinet may be pushed up against the cabin door, so that all the material may be reached conveniently from inside. The double doors, which are open in the picture, may be closed and locked when the outfit is not in use. Appropriate racks, drawers and shelves take care of all the supplies and equipment needed to clean the airplane inside and out, and to replace all supplies carried on board for the comfort of passengers, such as liquid soap, towels, cardboard containers, etc. The small rectangular tank on the left side is the liquid-soap supply, and the cylindrical arrangement on the other side is a drier for chamois skins used in cleaning. A hand-wringer is mounted on a shelf on one side.

All cleaning of airplanes at Brownsville is done at night after the mechanical work on the planes has been completed. By keeping all the necessary supplies in the portable cabinet, it is therefore unnecessary for anyone to have access to the stockroom during the night. Supplies for the cabinet are replenished from stock during working hours. By making the cleaning operations the last on the list of servicing items, it is assured that every airplane goes out on the line every morning without any marks of mechanical work on it.

Warning for mechanics

NAVY Department *News Letter No. 290,* dated Oct. 15, 1932, reports an unusual accident to an engine mechanic during the process of removing an engine from one plane and installing it in another. One of the crew who was checking the engine section for gasoline leaks, partially rotated the propeller to gain greater access to the underside of the crankcase, when the engine fired, causing the propeller to strike him. The installation was incomplete, and the engine had not been turned up for two days. An immediate examination disclosed that the ignition switch on the dash was in the *off* position, but tests indicated that although the left magneto was grounded, the right showed an open circuit. Upon screwing out the ground plugs of this magneto, it was found that the ground wire had not been making contact due to the plugs not having been screwed in tightly. No material was found to be faulty, and the magneto had previously functioned normally. This occurrence would suggest the importance of checking out the grounding of both magnetos before attempting any maintenance work involving the rotation of the propeller.

AIRCRAFT AT WORK

Farm mortgages by airplane

THE time required to raise money on the old homestead in the vicinity of Council Bluffs, Iowa, has been materially reduced through the activities of Messrs. McMillen and Wimer and their J-6 Curtiss Robin. A special aerial camera, designed and built by Mr. McMillen has been installed in the airplane. Mortgage bankers who are called upon to make loans on farms or land have been employing the airplane to obtain air photographs of the properties. From pictures thus obtained the bankers' geologists and agronomists can evaluate the mineral value of the land, or can estimate closely the yield and value of standing crops. This method saves a great deal of time over the older system of sending out parties by road for the same purpose.

The airplane *vs.* Anthrax

IN the Gulf Coast section of Louisiana large herds of cattle are pastured in marshy areas in almost inaccessible locations. Every year it is necessary to protect them against anthrax (an infectious disease with a high mortality) by vaccination. To reach the herds ordinarily requires an hour by car and seven to eight hours search by boat. During the past year Dr. Louis Leonpacher, veterinary surgeon of Lafayette, La., has been able to make the same trip in 15 to 30 minutes by air. Chartering an airplane and a pilot, it has been found to be a simple matter to locate and round-up the animals, and to reach them without delay from a landing on some nearby lagoon. As the scope of this work develops, the doctor is contemplating the purchase of a plane of his own to be piloted by his wife.

Airplanes aid British oil production

DOWN in Arabia where the Iraq Petroleum Company pipes its crude product over long stretches of desert into Syria for shipment, an Avro Model 10 trimotor and a deHavilland Type 50 biplane chartered from Imperial Airways are performing a variety of important duties. These machines not only make periodic inspection runs along the pipe lines, but are useful also to transport material and provisions to outlying desert stations. They have also been valuable in survey work, particularly in spotting locations for drilling for water. Points where water is thus found are selected as sites for pumping stations along the line. Once the stations have been established the airplanes serve to keep the local managers in touch with field headquarters.

Reports of another use of aircraft for geological survey work in connection with the search for petroleum come from Australia, at present the only continent which does not produce oil. Co-operating with the Commonwealth Geological Advisor, units of the Royal Australian Air Force have been despatched to various parts of the country to make preliminary photographic surveys. Many large and rugged areas which are believed to contain oil deposits are practically inaccessible except from the air. An examination of certain hitherto unchartered portions of the coastline is also contemplated as a part of this program.

Aerial prospecting along the Yukon

BASED on Mayo Lake, just below the Arctic Circle and about 100 miles east of Dawson, three airplanes belonging to the Treadwell Yukon Company, Ltd., have been keeping prospecting parties over a large territory supplied with men, dogs and food. Operations started in 1928 with one plane, a Wasp-powered Fairchild. In the summer of 1930 a Bellanca Wasp was added, and later a deHavilland Moth. During the open season of 1930 the Fairchild maintained four parties of two men each, and in 1931 the two planes maintained nine two-men parties. The operations during both seasons were conducted without any injury to personnel or serious damage to a shipment. The Moth has been used chiefly as a spare and for emergencies.

Each prospecting unit consists of the prospector, a helper, two dogs and equipment and food to last the party about two weeks. Each party is flown to its assigned location, and arrangements are made for a time and place to meet the plane at some later date. At the appointed time they are picked up, make their reports, and are either equipped with new supplies for another period, or are transported back to headquarters or to a new location. In this way vast territories are covered which could never be reached otherwise.

Due to the unusual operating conditions in remote locations, the costs seem relatively high, but comparing them with the results obtained and the cost of doing equivalent work by any other means, they are exceedingly low. Careful records have been kept of all expenses, and the summarized figures for operations during 1931 are given in condensed form in the following table.

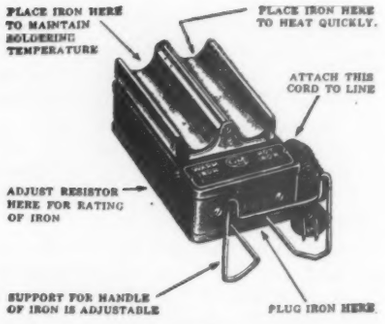
	Fairchild Twelve Months of 1931	Bellanca Five Months of 1931
Number of flights	221	112
Passengers carried	200	139
Freight, lb.	5,188	1,265
Flying miles	34,223	17,420
Ton miles	6,260.08	4,320.99
Cost per ton mile	4.05	3.75

Typical terrain in the Yukon country. Widely scattered small lakes afford convenient landing places for the Treadwell Yukon Company's seaplanes.

THE BUYERS' LOG BOOK

Soldering iron stand

A DEVICE which keeps soldering irons at the right temperature for use, thus avoiding over-heating and the consequent defective soldering which frequently results, is being marketed by the G-M Laboratories, Inc., of 1735 Belmont Avenue, Chicago. The stand has two cradles. In the left-hand cradle the iron receives only sufficient voltage to keep it at minimum soldering temperature for stand-by use. When in actual use it is placed in the right-hand cradle where full-line voltage is automatically applied to heat it up to best soldering temperature. This device not only keeps the iron ready for use at all times, but is said to effect a saving in operating current.—AVIATION, *February, 1933.*


PLACE IRON HERE TO MAINTAIN SOLDERING TEMPERATURE
PLACE IRON HERE TO HEAT QUICKLY.
ATTACH THIS CORD TO LINE
ADJUST RESISTOR HERE FOR RATING OF IRON
SUPPORT FOR HANDLE OF IRON IS ADJUSTABLE
PLUG IRON HERE

G-M Laboratories soldering iron stand

Waterproof glue in sheets

BONDING material for veneers, plywoods and laminated panels of practically any material, known as Tego Gluefilm, has recently been introduced in this country by Tego Gluefilm, Inc., of Terre Haute, Ind. The material is furnished dry in rolls to be cut and applied as required. It is uniformly 0.005 in. thick, and therefore the same glue-spread is always obtained. The bond is completed by pressing the plies together in a hot plate press without the addition of water or other liquids.

The bond is moisture-proof and is not subject to deterioration or decay. It does not stain light veneers, and the strength is limited only by the strength of the material laminated. For example, tests on wooden panels, wet or dry, have shown 100 per cent failure in the wood. Hot water and steam do not injure the bonding material, so that it is perfectly feasible to steam and bend Tego bonded panels into curved or irregular forms. — AVIATION, *February, 1933.*

Airport receiver

RADIO-AIRE, a general purpose radio receiver designed particularly for airports has recently been announced by Lear Developments, Inc., of Chicago. The set covers the entire frequency range from 235 to 720 kilocycles, making possible the reception not only of radio beacon signals and two-way aircraft telephone reports, but also covers the Naval communications and entertainment broadcast bands. The outfit is self contained, including a full dynamic speaker, and operates from alternating current. — AVIATION, *February, 1933.*

"Little cut-up" jig saws

HIGH-SPEED jig saws embodying unusual features, designed particularly for the rapid cutting of irregular curves and shapes from thin sheets of material (paper, plywood, aluminum, etc.) are produced by Beebe Bros., Inc., of Seattle, Wash. A number of models, all electrically driven by fractional horsepower motors, are available which will handle materials up to 2 in. in thickness. The depth of throat of the machines ranges from 16 to 26 in. In construction these tools are very simple. Saw blades are held in a vertical position (passing through a work-table) between the ends of a pair of long, cantilever multileaved springs. The sawing motion is obtained by connecting the lower end of the saw blade to an eccentric crank bushing on the motor shaft by means of a simple connecting rod.—AVIATION, *February, 1933.*

Lear "Radio-Aire" airport receiver

Stainless steel cable

STAINLESS steel control cables to meet Navy Specification M-77 and Air Corps Specification 10298 are now being manufactured by the Hazard Wire Rope Company, whose general offices are at 230 Park Ave, New York. This application in the aeronautic field followed the successful usage of stainless steel rigging for sailing craft. For aircraft use it is available in the 7x19 construction in sizes of $\frac{1}{8}$ in., $\frac{3}{32}$ in., and $\frac{1}{16}$ in. diameters. In addition to being highly resistant to corrosion, this type of alloy steel cable is said to be practically non-magnetic, an important consideration where control wires run through cockpits in the neighborhood of magnetic compasses. — AVIATION, *February, 1933.*

Oil-proof hose

RUBBER tubing and hose, oil-proofed by means of a new compound—Paranite G.O.P.—has recently been announced by the Manhattan Rubber Manufacturing Division, Passaic, N. J. Hose lined with the G.O.P. compound, either in pure form, or combined with oil-resisting rubber in proportions depending on the requirements of service, is said to be entirely unaffected by petroleum derivatives. It is used for gasoline supplied to the carburetor on certain automobiles, and also for loading and discharge connections for various oil storage and delivery services.—AVIATION, *February, 1933.*

Bench grinder

BLACK & DECKER and the Van Dorn Electric Tool Company have recently announced a new 6-in. electric bench grinder, which is both compact and portable. It is regularly furnished with two grinding wheels with $\frac{1}{2}$-in. faces, one coarse and one fine. Two adjustable tool rests and wheel guards make it possible to grind a variety of angles at any position on the circumference of the wheel. These tools are regularly furnished with a 110-volt, 50-60 cycle single phase A.C. motor. AVIATION, *February, 1933.*